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CONSTRUCTION WORKS FOR HYDRO-ELECTRIC POWER PLANT OF THE MISSISSIPPI RIVER POWER CO. AT KEOKUK, IA., AUG. 11, 1911.

Water Power Development on the Mississippi River at Keokuk, Iowa.

A bold project for developing from 200,000 to 300,000 HP. at the Des Moines Rapids of the Mississippi River, by means of a dam across this great river from Keokuk, Ia., to Hamilton, Ill., is now being carried into execution, with the prospect of being completed in about two years. This is one of the notable water-power developments of recent years, and will be one of the largest plants of the kind in this country.

Between Montrose and Keokuk, Ia., a distance of about 12 miles, the river bed has a fall of 23 ft., forming what is known as the Des Moines Rapids. The surface fall is about 23 ft. at low water and 16 ft. at high water, the greater part of this fall being in the lower eight miles. The river is in solid limestone formation, and its bed is practically smooth, so that there is no broken water or surface disturbance except during very low water and at the lower end of the rapids, where ridges of harder rock cross the bed. The river channel itself is only navigable at high water, however, and navigation past the rapids is provided for by a canal. The river here is nearly a mile wide and has a depth of about 7 ft. at mean water. In a 20-year range of observations, its volume of flow ranged from 20,000 cu. ft. per sec. at low water to 372,500 at flood stage.

The dam will raise the water level about 35 ft. at the dam, submerging a considerable area of flat land along the banks, and forming a pool about 60 miles in length. About 35% of the submerged land is on the Illinois side, where the bluffs are nearer to the river than on the Iowa side. On the latter side, however, the tracks of the Chicago, Burlington & Quincy Ry. will have to be raised for a distance of about nine miles. The normal working head on the hydraulic machinery at the power house will be 32 ft., but the head may vary from 21 ft. at high water to 39 ft. at low water.

Below the site of the dam and about 1,000 ft. below the lock of the government canal, is the Keokuk bridge; this was erected in 1866-1871, the superstructure being built by the Keystone Bridge Co. It has a 380-ft. drawspan and ten fixed through spans (with iron trusses) ranging from 151¼ ft. to 258 ft. The piers are of stone masonry, some resting on the rock and others on timber grillage; one of these is said to be about 6 ins. out of line, having been shifted on the smooth rock bottom by the movement of an ice gorge. The bridge has a roadway and two sidewalks; in the roadway is a single track for steam and electric railway service, highway traffic being stopped when a train or car crosses.

The project of utilizing the power of the river fall at this point is a very old one, dating back to 1848. The earlier schemes, however, provided only for utilizing a part of the flow by means of wing dams, and were for developing only about 10,000 HP. In the early 90's the Keokuk & Hamilton Water Power Co. was organized to build a wing dam and power canal on the east side of the river, the government navigation canal on the west side preventing the construction of development works on the west side. A bill granting the necessary authority was obtained from Congress in 1901, and this required the plans to be subject to the approval of the War Department.

The company engaged Mr. Lyman E. Cooley, M. Am. Soc. C. E., to investigate the matter. He estimated that 10,000 HP. was the maximum limit possible for a wing-dam scheme, but that this could be increased to about 40,000 HP. by a dam across the river at Nashville (8 miles above Keokuk and the head of the navigation canal), and further increased to 50,000 HP. by excavating a tail race below the power plant. Mr. Cooley then developed a project providing for a dam across the entire width of the river at Nashville, this dam to be 6,000 ft. long, with its crest 10 ft. above low-water level, and raising the high-water level about 5 ft. The power canal (on the east bank) was to be formed by a rock embankment in the river, and would widen at the lower end into a forebay closed by the power house. The estimates of cost (exclusive of the power house and machinery) were as follows: (1) Wing-dam project for 10,000 HP., $2,186,000 ($218 per HP.); (2) complete dam without tail race, for 43,000 HP., $2,443,000 ($57 per HP.); (3) complete dam with tail race, for 50,000 HP., $3,505,000 ($70 per HP.). Mr. Cooley also suggested the larger project of a dam at Keokuk, at the foot of the rapids, which would drown the old navigation canal, but conditions at that time did not appear to warrant him in going further into this latter scheme. The company was unable to finance its wing-dam project and the matter remained in abeyance.

A few years later the matter was taken up by Mr. Hugh L. Cooper, M. Am. Soc. C. E., consulting engineer, of New York, who proposed to dam the entire river below the rapids, as had been suggested by Mr. Cooley. He undertook to raise the funds and carry out the work, organizing for this purpose a new company which took over the rights of the old company. The plans received the approval of the War Department and of the Chief of Engineers (U. S. Army). A proposition that the government should pay the actual cost of building the new lock and appurtenances was disapproved by the Chief of Engineers on the grounds that (1) such an arrangement between the government and a private corporation in the construction and maintenance of a public improvement was not desirable, and (2) that the existing works are amply sufficient for navigation requirements, the new lock being necessary only because the construction of the dam will render these existing works useless. In 1905, Congress passed a bill authorizing the company to proceed with the construction of the works for this new and enlarged scheme.

The development of the water power at the Des Moines Rapids has now been undertaken by the Mississippi River Power Co., of Boston, Mass. Mr. Edwin S. Webster is President and Mr. Hugh L. Cooper, M. Am. Soc. C. E., is Vice President and Chief Engineer. It is carrying out the construction work by its own engineering department and force, under the direction of the Chief Engineer. The firm of Stone & Webster, of Boston, through its engineering department, has direct charge of the electrical installation, including the transmission and distributing lines; the managing department of this firm will manage the property and will have charge of the sale of power during the construction period.

The general scheme is shown by Fig. 1. It comprises three important features: (1) A spillway dam (surmounted by a bridge) extending 4,570 ft. from the east side of the river; (2) a power house 1,700 ft. long, parallel with the river and extending downstream from the end of the dam; (3) a short dam with navigation lock extending from the downstream side of the power house to the west shore, forming the forebay for the power house and including also a basin or dry dock at the shore end.

The site of the power plant is about 220 miles west of Chicago, 180 miles east of Kansas City and 140 miles north of St. Louis. Allowing for a transmission distance of 220 miles, it is the

center of a population of about 4,570,000, according to the census of 1910. The city of Keokuk has a population of 15,000, and is conducting a campaign with a view to developing the city as an industrial and manufacturing center. The plant now under construction provides for an output of 120,000 HP., and a 99-year contract has been made already for the supply of 60,000 HP. to the street-railway and electric-light and power companies of St. Louis.

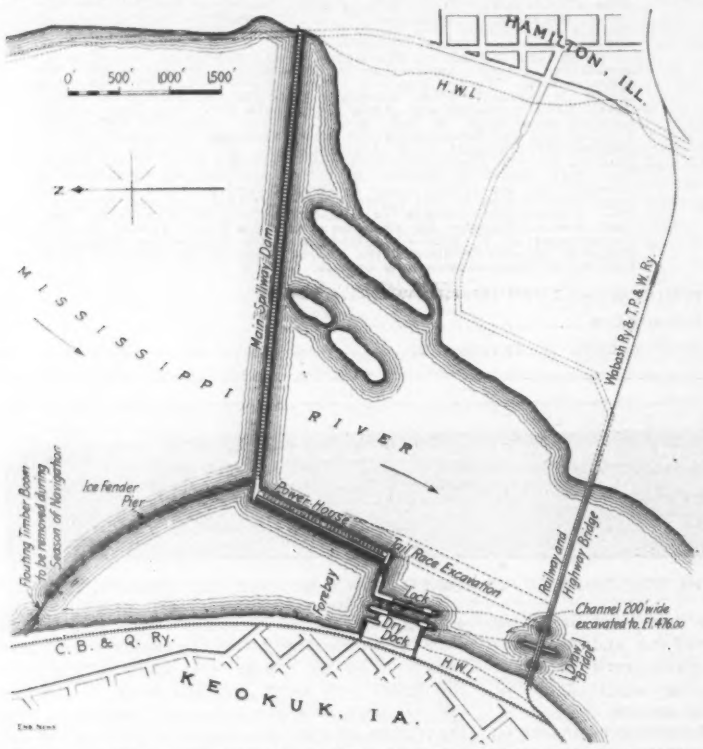


FIG. 1. GENERAL PLAN OF THE DAM AND POWER PLANT NOW BEING BUILT ACROSS THE MISSISSIPPI RIVER AT KEOKUK, IA.: MISSISSIPPI RIVER POWER CO.

(Hugh L. Cooper, M. Am. Soc. C. E., Chief Engineer, Keokuk, Iowa.)

Engineering works rarely receive much attention on the part of the public, but the work at Keokuk forms a local attraction, the people of the surrounding country having a popular interest in "the big dam across the Mississippi," as the project has been in the public eye for so many years. In fact, excursions are run from nearby points to Keokuk, with the dam as the main attraction. To meet this condition and still provide for excluding the public from the works, the power company has erected on each side of the river a covered pavilion or observation platform, which is provided with seats and from which there is a very good view of the work as well as of the scenery along this part of the river.

The Main Dam.

The main dam is a concrete structure extending 4,278 ft. from its east abutment, which abutment is 290 ft. long to the east bank of the river. Its design is shown in Fig. 2, and the structure is peculiar in being built first as a viaduct and then converted into a dam. As built in the first place it will consist of a series of 119 arch spans 30 ft. long on piers 6 ft. thick, forming a bridge 29 ft. wide on top. Later, each 30-ft. opening will be closed to the spillway elevation by a dam or weir, so that in the total length of 4,278 ft. there will be 3,570 ft. of spillway. The water level will be raised above the spillway crest by steel gates closing each 30-ft. opening up to the springing line of the arches. These gates will slide in grooves in the sides of the piers, and will be operated from a traveler running on a track laid upon the bridge. Each 30-ft. length of dam is self-sustaining, independent of any help from the piers, and is keyed to the piers (by means of grooves in the latter) simply to make the joints water-tight. The piers are 6 ft. wide, and are 30 ft. apart in the clear; they are 42 ft. long on the base and 36 ft. at the top. The 30-ft. openings are spanned by arches of 19 ft. radius, having a thickness of 29 ins. at the crown. The roadway carried over these arches and piers is 29 ft. wide and about 53 ft. above the river bed.

The east abutment is a solid gravity-section dam extending from bed-rock in the hillside to the end of the spillway. A wing wall extends downstream, continuing the abutment face next to the spillway. The abutment and wing wall will retain a fill of rock and earth on the downstream side, the fill being dressed to conform to the slope of the wing wall.

The dam or spillway is of gravity section (self-sustaining, as noted above), and no steel reinforcement is used anywhere. It has a vertical face on the upstream side, with a curved crest and ogee curve on the downstream side; the upper part of this curve is a parabola, while the lower portion is shaped to a circular curve which ends at a horizontal tangent at the toe. In normal section it is 42 ft. wide on the base and 32 ft. high from the river bed to the crest. The normal water level will be raised about 24 ft. by the dam, and this will be increased to 35 ft. by the gates.

The east end of the dam, now under construction, is being built across the dry bed rock underlying the bottom lands which lie between the river and the bluffs. The bed rock has but a slight earth cover and requires only shallow excavation to secure a solid base for the dam, this base being about 4 ft. below the top of solid rock. When the river is reached, sections about 1,000 ft. in length will be built within enclosures 75 ft. wide formed by cofferdams. These cofferdams are of similar construction to those at the power-house, described later. The first of these cofferdams extending out from the Illinois shore was completed and pumped out in August.

The foundation work is not difficult, the river bottom being of solid blue limestone rock extending to a great depth. The seams (present in all sedimentary rock) are not water bearing, and there are no pockets of softer material. The bluffs along the river also are of good solid rock. The character of the rock is tested at intervals by 4-in. drill holes sunk to a depth of about 30 ft. Each hole is tested by compressed air and by pumping water, in order to determine the presence of any seams or fissures coming to the surface or connecting the holes. Furthermore, a diagram is plotted from the drilling of each hole, showing the penetration as ordinates to a scale of time in minutes. If the work progresses steadily, as in solid rock, the curve will be regular; any rapid increase in speed (indicating soft material) would show a sharp drop in the curve and lead to investigation. As a check upon the diagram the air pressure at the drill is plotted also.

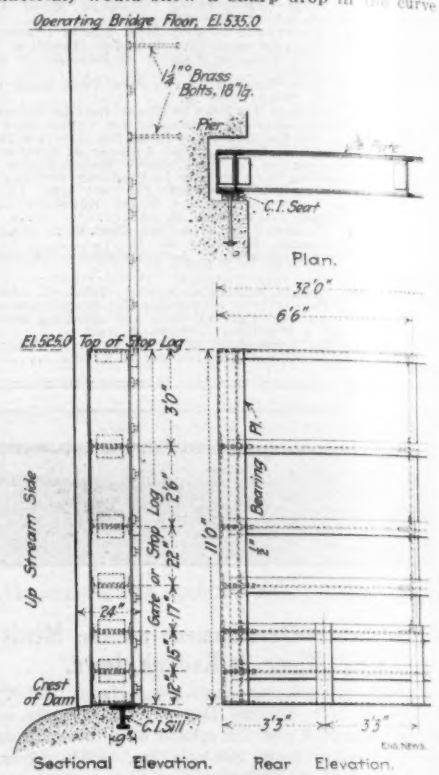


Fig. 3. Steel Gates for Closing the Spillway Openings Above the Crest of the Dam.

The concrete is a 1:3:5 mixture, using broken limestone crushed to a maximum of 4½-in. size. No screenings are used. The mixture is made very wet, so that the voids are always thoroughly filled. Pudding stone is used to a limited extent. The concrete has a very smooth dense surface.

The average rate of progress on the dam is 180 ft. per week, and the concreting averages 625 cu. yds. per day, with a maximum record of 750 cu. yds. This is for the "viaduct" only, and is exclusive of the sections of dam which will be built later to close the openings. The batches of concrete average 1⅛ cu. yds., and are deposited by drop-bottom buckets of this capacity. The

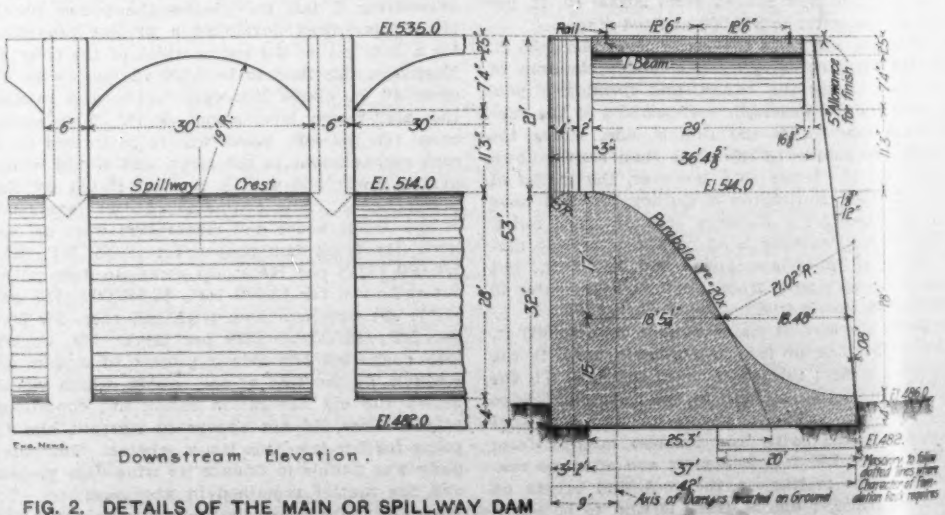


FIG. 2. DETAILS OF THE MAIN OR SPILLWAY DAM ACROSS THE MISSISSIPPI RIVER.

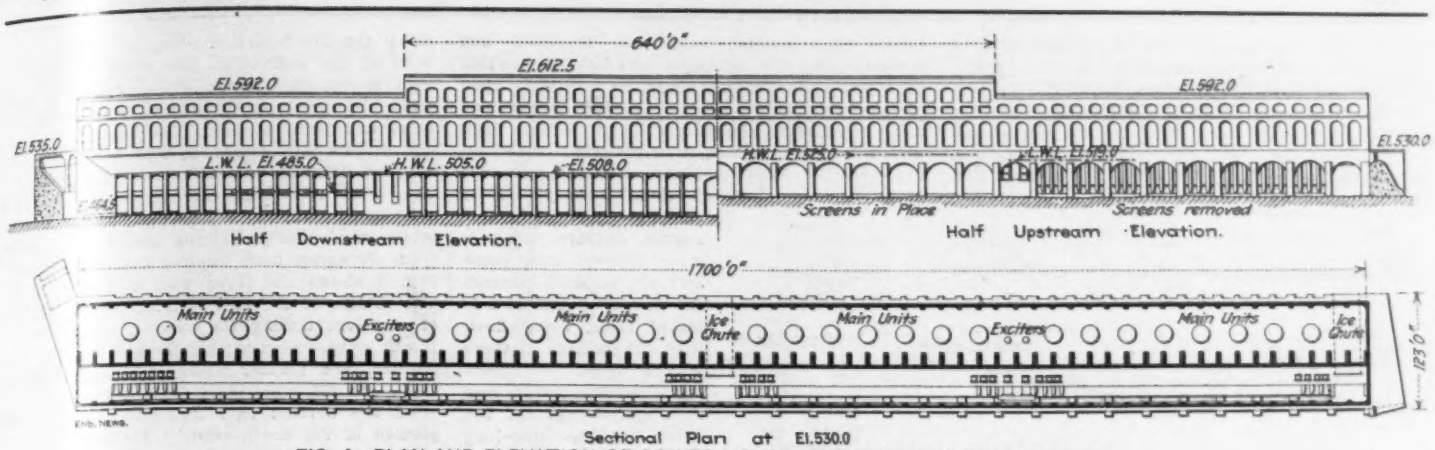


FIG. 4. PLAN AND ELEVATION OF POWER HOUSE: MISSISSIPPI RIVER POWER CO.

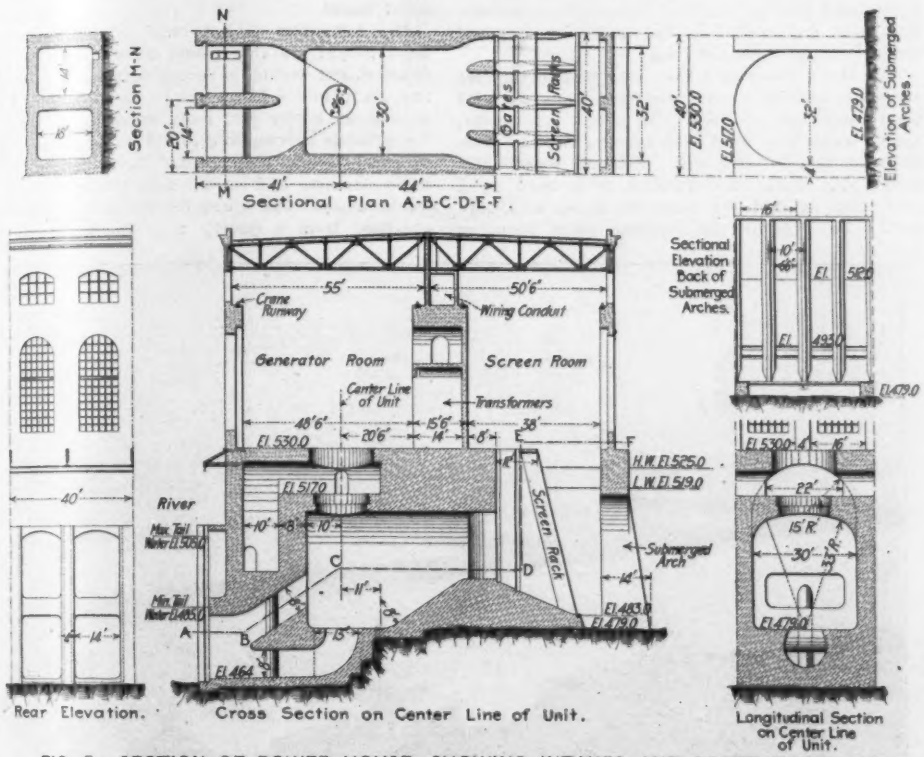


FIG. 5. SECTION OF POWER HOUSE, SHOWING INTAKES AND DRAFT TUBES OF THE MAIN UNITS.

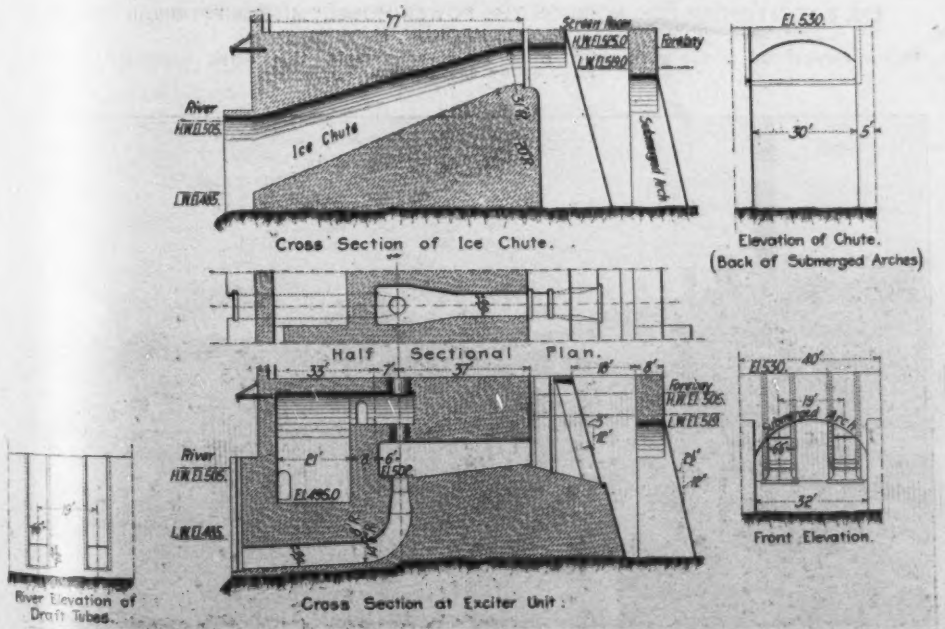


FIG. 6. ICE CHUTES AND THE INTAKES AND DRAFT TUBES OF THE EXCITER UNITS.

mixing and handling of the concrete are described later.

GATES.—The gates or stop-logs (which act as flash-boards) for closing the openings above the spillway crest, are steel panels 11 ft. high and 32 ft. long over all; these slide in grooves in the piers, and the downstream sides of their ends rest against cast-iron seats set into the face of each groove. Each gate consists of a framework of 18-in. I-beams covered with ⅜-in. steel plate on the upstream face. The construction is shown in Fig. 3. These gates will be handled by a traveler or derrick car running along the bridge which forms the top of the dam. When raised they are held in position by a locking device.

Power House.

The power-house, shown in Fig. 4, will be built parallel with the stream, and its substructure will be practically a solid mass of concrete 1,700 ft. long and 123 ft. wide, with its floor 45 ft. above the river bed. In this concrete will be formed the wheel pits and the conduits or passages for the water to and from the wheels. The superstructure will be of steel frame construction with walls of brick and concrete, and a tile roof. It will be about 125 ft. wide, divided longitudinally by a concrete wall forming a series of arched recesses in which the transformers will be placed. A section of the substructure and superstructure is given in Fig. 5. The river side of the building will be the generator room; the forebay side will be the screen room. The entire building will have an upper story, in which will be placed the oil switches and other electrical auxiliaries. The steel framing for this second floor will be suspended from the roof trusses.

There will be 30 generating units and four exciter units, but the first installation will consist of 15 generators and two exciters. Each main unit will consist of a 7,500-KW. revolving-field alternator mounted on the upper end of a vertical shaft whose lower end carries a single-runner turbine of the Francis type. The revolving parts will be carried by a roller bearing, which will be interchangeable with an oil-pressure thrust bearing. The normal head on the wheels will be 32 ft., but the head will range from 21 to 39 ft., according to the stage of water in the river.

The intakes will be on the western side of the power-house, taking water from the forebay formed between the building and the shore (Fig. 5). The draft tubes will discharge into a tail-race channel excavated along the river side of the building and extending downstream as far as the bridge (Fig. 1). Submerged arched openings in the forebay wall open into the screen and gate room inside the building, and the intakes are protected by screens which may be removed for cleaning or repair. Each intake is controlled by four head gates placed behind the screens. The gates will be operated by an overhead traveling crane. Each exciter unit has a single intake and discharge conduit; these are also of the vertical type, and are provided with the same screen and gate arrangements as

those of the main units. Two ice chutes provide for sluicing out ice floating in the forebay. These are arched openings inclined from the forebay to the river level; they are 30 ft. wide, with a height increasing from 10 ft. at the upper end to 23 ft. at the lower end. These openings are normally closed by gates. The ice chutes and exciter tubes are shown in Fig. 6.

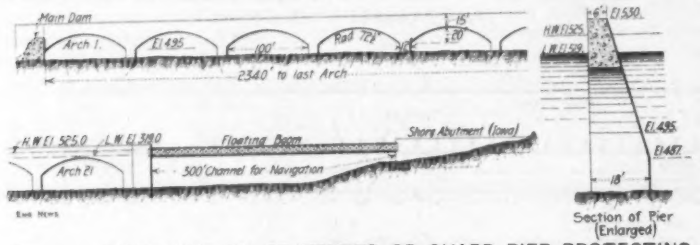


FIG. 7. CONSTRUCTION OF FENDER OR GUARD PIER PROTECTING THE FOREBAY.

Between the downstream end of the power-house and the lock is an abutment 100 ft. long, with a vertical back and battered face. This is provided with an inclined sluiceway or ice chute 15 ft. wide for the discharge of floating ice, etc. At the junction of this abutment with the lock is a power-house for a water-power plant to operate the lock gates and valves.

To exclude logs, drift and ice from the forebay, there will be a concrete fender or guard pier 2,340 ft. long, extending upstream from the power-house and curving in towards the shore. A 300-ft. opening for navigation is provided, between a shore abutment and the head of the pier, and except during the season of navigation this will be closed by a floating boom built of timber trusses about 5 ft. deep. The pier, Fig. 7, will be 6 ft. wide on top and 18 ft. on the bottom; and will have 21 submerged openings 100 ft. wide to admit water from the river to the forebay. The piers between the openings will be 12 ft. wide. The openings will have arches of 72 ft. radius, the intrados being 4 ft. below low water, while the top of the pier is 11 ft. and 5 ft. above low and high water respectively.

Cofferdam.

The power-house work is being done within an area of about 35 acres of the river bottom, a cofferdam having been built and the enclosed space pumped out. The canal embankment forms the western side of the enclosure. To enable the permanent work to be commenced as soon as possible the upper half of the area was first enclosed and pumped out. This pumping (for 15 acres) was done by a single 18-in. centrifugal pump working continuously for 60 hours from April 28 to April 30; this delivered an average of 10,000 gals. per minute. The entire area is now enclosed, and the middle cofferdam has been cut in places to permit of laying tracks, etc., for the full length of the work. The cofferdam shows very few leaks and these of a minor character, but a little water seeps through from the canal. All water from leakage and rainfall is handled readily by a 3-in. low-lift centrifugal pump. Fig. 8 is a view of the work as it existed on May 2, 1911. In the foreground are the government canal and the tracks of the C., B. & Q. R. R.; the upper part of the site had been enclosed and pumped out, and cribs were then being placed for the cofferdam enclosing the lower part of the site. This has been completed since then (as noted above), the entire area pumped out, and the middle line of the cofferdam (now not necessary) partly cut away. The white spots on the opposite shore indicate the works at the Illinois end of the dam.

The cofferdam is composed of cribs of square timber, the cribs being 24 ft. long and 16 ft. wide, with the tops about 15 ft. above the river bed. Each crib contains 22,000 ft. B. M. of lumber. To determine the form of the rocky surface of the river bed at each crib a raft of the size of the crib was moored in position, and a sounding pole used to get the depth along each side. The bottom portion of the crib was then built on shore, and cut to the shape shown by the soundings. This portion was then launched and floated to its site, where it was held in position by ropes while the upper portion was built upon it. Its own weight sunk it to the bottom and when finished to the proper height it was filled with loose rock to hold it in position. When all the cribs for the cofferdam were in place, the 12-ft. openings between them were closed by stop-logs on horizontal square timbers which were lowered into place and drift-bolted against the corner posts of adjacent cribs, being flush with the outside timbers of the cribs. A sheeting of vertical planks was then spiked against the cribs and the stop-logs of the outer face of the cofferdam, each plank having been driven down hard on the bed rock before it was spiked. The cribs are braced on the inside by diagonal timbers let into the bed rock.

To make a watertight face, clay and earth were deposited outside of the sheeting, being dumped from cars on a track laid along the cribs, which track was used also for the railway cars carrying the crib timbers. This fill was finally faced with loose rock dumped from cars, as a protection against the wash of waves and current. To prevent the current from scouring away the fill deposited along the east or river wall of the cofferdam, the north or upstream wall is extended about 50 ft. beyond the river wall, and protected by a heavy pier with battered and pointed nose. This projection checks and diverts the current, so that material for the fill was dumped into comparatively still water. The cross cofferdam extends beyond the river wall in the same way, protecting the lower part of the work and preventing the diverted current from swinging back against the lower portion. Fig. 9 shows the river wall of the cofferdam. The middle of the raft is lying against a panel of stop-logs closing the space between two adjacent cribs. Beyond this the sheeting has been applied, and further along is a train dumping the earth fill. The dark line at the right (beyond the derrick car) indicates the projecting portion of the north wall of the cofferdam, described above. To the left of the white stone pile may be seen the bobtail swing bridge which carries the construction track over the government canal.

The cofferdam is not built to full maximum flood height, as this would have been very expensive and would have necessitated raising all the plant to an inconvenient elevation. It was considered better and more economical to allow for possible overtopping and flooding of the work by exceptionally high floods. This would do very little damage and would result only in a few weeks delay. The stone for filling the cribs was obtained from a quarry near the north end of

FIG. 8. COFFERDAM FOR WORK ON THE POWER HOUSE: MISSISSIPPI RIVER POWER CO., KEOKUK, IA.

(In the foreground is the government canal for river vessels, this being separated from the river by an embankment.)

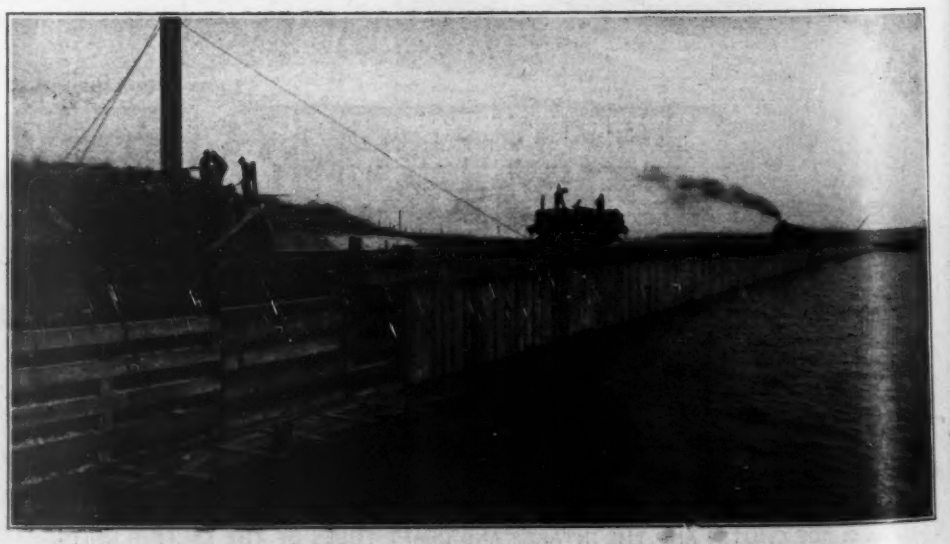


FIG. 9. CONSTRUCTION OF THE COFFERDAM FOR THE POWER HOUSE.

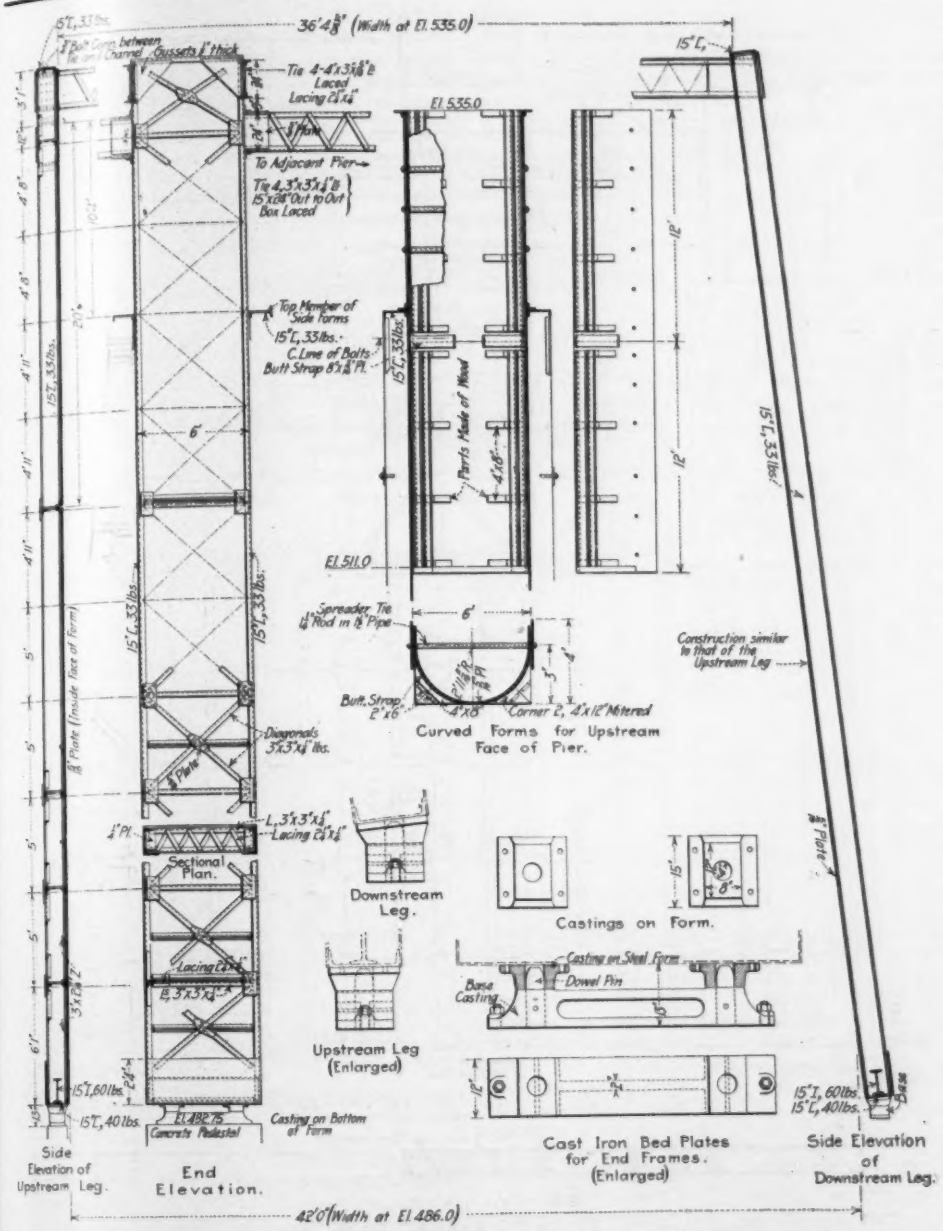


FIG. 10. STEEL FORM CONSTRUCTION FOR THE MISSISSIPPI RIVER DAM: END PANEL OR LEG FOR PIER FORMS.

the company's construction plant. The earth stripping and the blasted rock were loaded by two 90-ton steam shovels into 12-yd. air-operated dump cars hauled on standard-gage tracks by tank locomotives, the locomotives also dumping the cars by means of the air cylinders.

Some very rapid work was done in the construction of this cofferdam, special steps being taken to secure this in order that the work on the permanent construction might be undertaken as soon as possible. The first seven cribs were placed in January, 1911, when the river was frozen over; they were built on the ice, and then lowered through holes cut at the proper positions. Warm weather then caused the ice to break up, and the work was carried on in the way above described in relation to the main dam.

Work on the cofferdam to enclose the upper half of the area was started from the shore at the upper and lower ends simultaneously by two different crews of 15 men each; 88 cribs were required and it was desired to have each crew place, fill and complete one crib per day. To promote rapid work, rivalry between the two gangs was encouraged, and an increase in wages promised when they should have placed an average of one crib per day for a period of 25 working days. As a result of this, the desired rate was exceeded materially. Most of the men engaged in this work were French Canadians.

The same type of cofferdam construction will be used in building the dam across the river, as already noted.

Lock and Basin.

Navigation past the rapids is provided for at present by a canal and locks on the Iowa side, as the river channel can be navigated only at high stages of water. These works were built by the U. S. Government and completed in 1877. They are shown on the construction plan, Fig. 20. The canal is eight miles long, and is separated from the river by an earth embankment faced with riprap. It has three locks each of 8 ft. lift and provides for vessels having a minimum draft of 6 ft. The lock chambers are 225 × 78½ ft., with a depth of 6 ft. of water on the sill. As already noted, these locks (about three miles apart) will be submerged (due to the raising of the water level) by the construction of the dam. The raising of the water in this way will materially improve navigation, as it will not only eliminate the canal and these locks but will give deeper water in what are now shallow portions of the river above the canal. In fact, there will be slack-water navigation for a distance of about 60 miles above the dam at low stage.

The new work includes a single lock of 40-ft. lift, which will have a chamber 400 × 110 ft., with 8 ft. of water on the upper sill when the reservoir is drawn down to its extreme limit. Alongside of the upper entrance to the lock is the 110-ft. entrance to a basin 150 × 460 ft., for dry-dock purposes, as shown in Fig. 1. The space between the dry-dock and the Iowa shore will be filled and graded to the new level, providing ample room, railway facilities, etc., for the offices, repair shops and other works maintained at this point by the Engineer Corps, U. S. Army.

Steel Forms for the Dam.

The use of steel forms on a large scale is one of the many special features of the work and these forms are of a novel design originated by Mr. B. H. Parsons, the Mechanical Engineer. They are built up of structural steel shapes and faced on the inner side with steel plates. For the pier form, each end consists of a vertical panel or leg the full width of the pier (Fig. 10), and to the sides of these are bolted horizontal girders 5 ft. high forming the side panels, as shown in Fig. 11. Each panel is slightly shorter than the one below, to provide for the batter of the end of the piers, but they are made interchangeable so that a panel for any given height can be used at any pier. In the upper panels, diagonal members are used so that the structural framing forms a truss. This is done in order that when the lower panels are removed the upper ones will be strong enough to carry the load of green concrete in the arches.

Each arch center is composed of three-hinged trusses, Figs. 11 and 14, and made in two sections, with a transverse joint at crown; it consists of a series of shallow trusses carrying the curved plate which forms the lagging. At the springing they are seated on the pier forms; at the crown are horizontal lugs which come into line and admit of driving longitudinal pins. This ensures accuracy and rigidity. To release the center, the pins are driven out, allowing the two half forms to fall away. The trusses are connected at the springing line by tie rods, which are set up to the required tension by means of turnbuckles. The centering performs no work in holding the pier forms in position, this being done by side

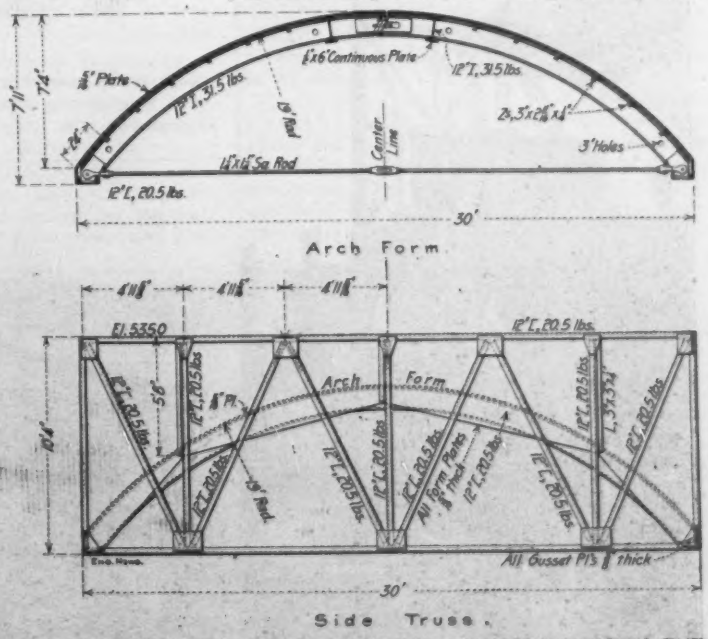


FIG. 11. ARCH FORM AND LONGITUDINAL TRUSS CONNECTING THE TOPS OF THE PIER FORMS.

trusses (Fig. 11) outside the line of the arch. These trusses are bolted directly to the pier forms, and accurate spacing is assured at each assemblage of the parts. The working plant includes ten complete sets of pier and arch forms.

A good idea of this steel form construction is given in Fig. 13, which is reproduced from a photograph taken on Aug. 21. The view shows the cofferdam enclosing a section of the river bed ahead of the dam construction work.

A special feature of the work is the manner in which accurate position of the pier forms is secured. In advance of the work a small concrete pedestal is built on the rock bottom at the location of each end form; this extends the full width of the pier and has upon it a cast-iron shoe which is set and anchored at lines and levels given by the engineer. The shoe has two pins or dowels on the top face, to engage with holes in the bottom member of the end form. Thus each pier form is given exact position, and is held in position by the dowel pins at the base and the connections to the longitudinal trusses and struts at the top. The forms are not set exactly plumb, but with an inclination of about 5/16-in. in the total height to the rear (or toward the completed work); thus any variation due to expansion will be towards the exact plumb position, instead of causing the slightest inclination forward. In very hot weather this inclination has been reduced to 2/16-in. To prevent the trusses from binding between the pier forms, due to expansion, their ends are faced with paraffine; then, when the form is to be taken down, a slight pressure with a jack moves the strut out sideways till it is clear of the pier forms.

For the dam sections between the piers, a pair of steel trusses will be fitted to recesses in the latter; one of these (near the upper side of the dam) is a little above the crest level and the other (at the lower side) is a little above the toe. Beneath these will be fitted the forms carrying the lagging shaped to the contour of the downstream face of the dam. For the vertical upstream face, steel panels will be braced between the piers. This is indicated in Fig. 12.

All forms are left in place for about a week, with five days as a minimum. As to speed of erection, the record is the erection of a complete pier and arch form in 5 hrs. 20 mins.

Travelers.

One of the most interesting features of the work is the use of a steel traveler for handling and placing the concrete, this machine closely resembling the travelers used in steel-bridge erection. The cars carrying the concrete buckets are run under the rear end of the traveler; a trolley then picks up a bucket, runs it out on the forward cantilever end and lowers it to the cofferdam or form. As the work advances, a track is laid along the roadway over the arches, and the machine is moved forward. This is shown in Fig. 15.

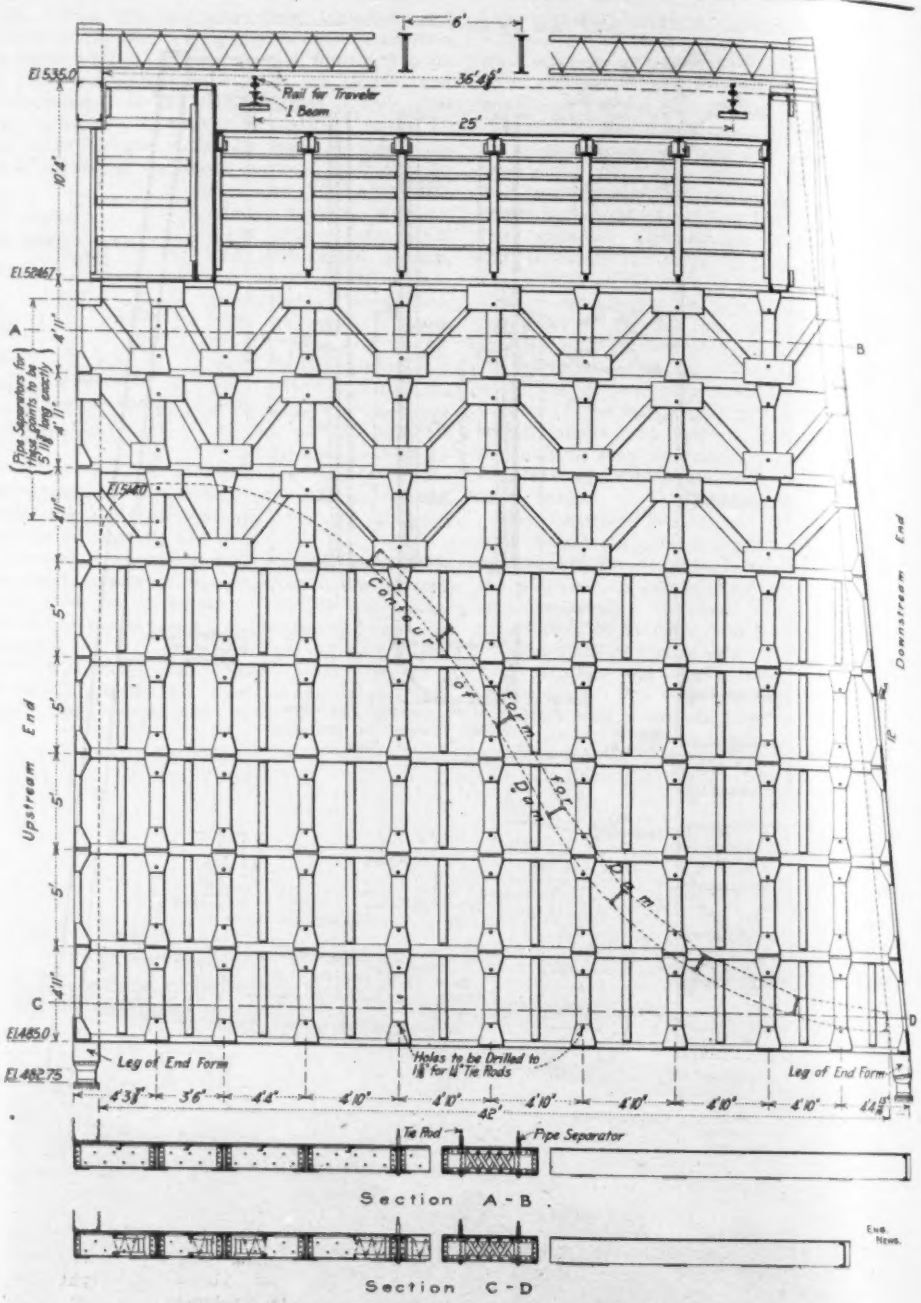


FIG. 12. STEEL FORM FOR SIDE OF PIER.

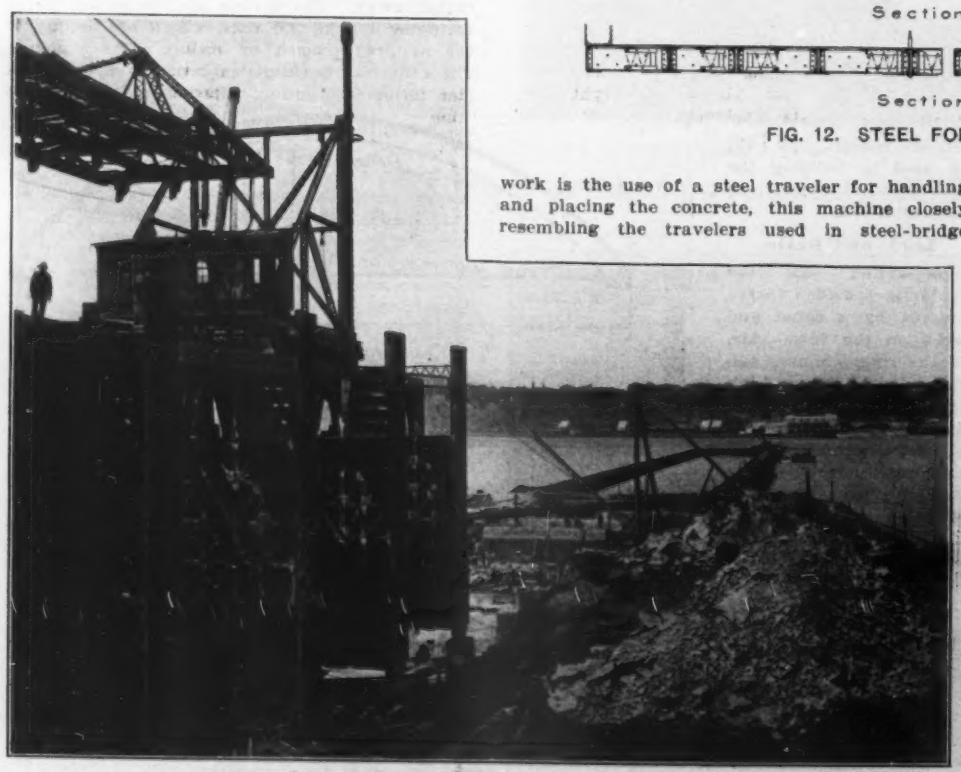


FIG. 13. ERECTING THE STEEL FORMS FOR PIERS OF MAIN DAM, AUG. 21, 1911.

The traveler consists of two steel trusses 25 ft. apart, the rear portion having a length of 90 ft. and the cantilever portion 150 ft. The rear portion is mounted on six wheels running on a track of 100-lb. rails carried by steel I-beams embedded in the concrete surface of the bridge which surmounts the dam. These I-beams are to carry the rails of the permanent travelers for handling the gates. The top of the I-beam is flush with the surface of the concrete, and pockets beneath its upper flange (to receive the bolts for the rail fastenings) are formed by cast-iron blocks which are made in two pieces so that they can be removed when the concrete has set. Three railway tracks are laid through the rear or supporting portion of the traveler, there being a clearance of 24 ft. in width and 16 ft. in height. On these tracks are run the concrete trains, a semaphore over each track (on the back of the elevated engine house) being used to signal the enginemen when to run in their trains.

The total height of the traveler is 65 ft. and its deck is 25 ft. above the rails. This deck carries three runways 210 ft. long, one over the center of each supply track. On each of these runways is a traveling trolley hoist, with its hoisting and traveling cables operated by two compressed-air engines, a large receiver being mounted on the machine. The engines for each hoist are operated by a man stationed in an engineroom below the deck, where he has a good view of the cars below and the runways above. At the end of each runway is a boy who has full view of the work below and signals the engineman by telephone as to the movements to be made. This avoids the confusion of hand signals or shouted orders. The concrete is delivered in 1½-yd. drop-bottom buckets placed on flat cars; the trolley picks up a bucket, runs it out, lowers, raises and returns it.

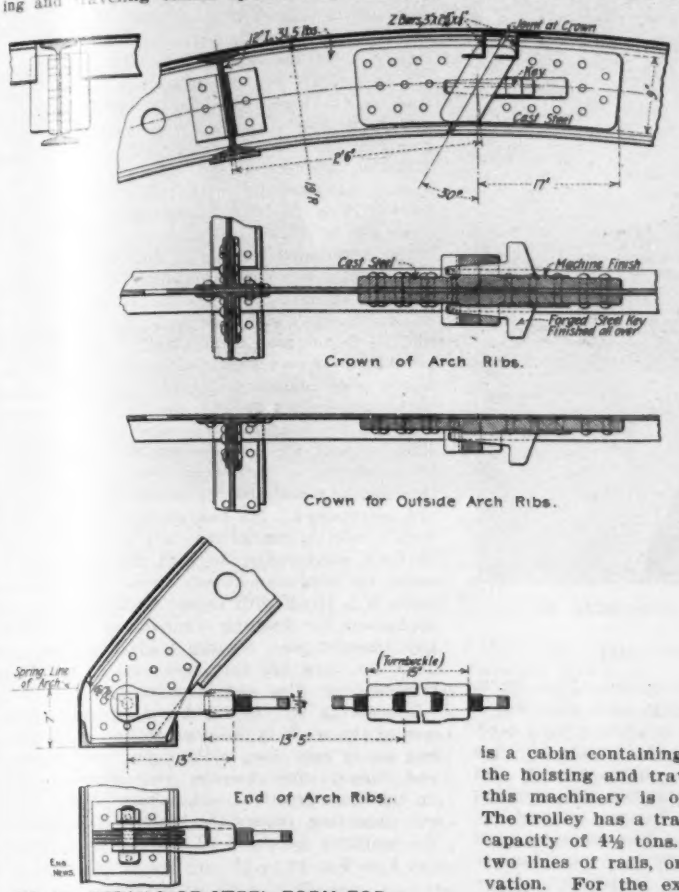


FIG. 14. DETAILS OF STEEL FORM FOR ARCHES: MISSISSIPPI RIVER DAM.

The machine weighs, with all its machinery, about 175 tons; this weight is carried by six wheels on the two rails. The equipment includes three 10-HP. engines for traversing the trolleys, at 500 ft. per min.; and three 40-HP. engines for hoisting, at 150 ft. per min.

For the complete work on the dam there are four travelers in use. The first is a steel frame with booms for erecting the forms; this is carried by rails on stringers supported by long ties resting on the side trusses of the last completed steel forms, which thus serve as falsework. Following this is the cantilever traveler above described, which is used solely for handling and placing concrete. Behind this is a steel frame with booms for taking down the forms on the completed work behind the concreting traveler. The fourth traveler is also a steel frame with booms, and is used for depositing the concrete of the dam sections between the piers; the buckets will be lowered over the side and dumped into chutes which deliver it to the required position.

For the work at the power-house section on the Iowa side, there are four cantilever gantry cranes, which are shown in Fig. 16. These have bridges 195 ft. long over all; the main part spans the excavation and is supported by two bents 120 ft. apart. Beyond one bent the bridge extends 60 ft. as a cantilever, spanning tracks laid along the side of the excavation. Behind the other bent is a cabin containing the machinery for driving the hoisting and traveling cables of the trolley; this machinery is operated by compressed air. The trolley has a travel of 170 ft. and a hoisting capacity of 4½ tons. The four cranes travel on two lines of rails, one at each side of the excavation. For the excavation, these cranes will handle the skip loads of broken rock, dumping them into cars on the upper level, these cars being run on tracks spanned by the cantilever. For the concreting, they will take the dump-buckets from cars on the same tracks and convey them to the required point. To the left and beyond the travelers is the cofferdam. Each crane has two 40-HP. engines for hoisting, at a speed of 150 ft. per min.; and two 10-HP. engines for traversing the trolley, at 500 ft. per min. As on all the other travelers, the engines are operated by compressed air. The total weight of the crane, with all its machinery is about 75 tons, which is carried by two wheels under each bent.

Organization, Materials and Equipment.

The execution of the work is under the direction of Mr. Hugh L. Cooper, M. Am. Soc. C. E., the Chief Engineer, and is done by company force entirely, as noted already. The construction work is divided into two separate departments, each of which has its own organization, force and plant. The Illinois division is building the main dam, and Mr. D. P. Cooper is Engineer in Charge. The Iowa division is building the power house and lock, and Mr. H. T. Herrick is Engineer in Charge. Mr. B. H. Parsons, M. Am. Soc C. E., is Mechanical Engineer for all divisions of the work. The main office, with drafting, supply and other departments, is at Keokuk, and has telephone communication with all parts of the work on both sides of the river.

There is an extensive system of service tracks, all tracks and rolling stock being of standard gage to facilitate the handling of material. The Chicago, Burlington & Quincy Ry. extends along the west bank, and from it are led spurs to the construction yard of the Iowa division of the work (Figs. 1 and 20). A track had to be carried also across the canal to the power-house site, which necessitated the construction of a trestle and a drawbridge. This drawbridge is a steel through-truss structure of the bobtail type (Fig. 9), with a main arm of 114 ft. and a counterweighted short arm of 46 ft. Below the dam the river is crossed by the railway and highway bridge already noted, over which run the Toledo, Peoria & Western and the Wabash Rys.; a branch from this last is built up the east bank to the construction yard of the Illinois division of the work (Fig. 17). The power company has running powers over both these lines and over the C., B. & Q. Ry. as far south as the sand-pumping plant on the Des Moines River. Material is handled mainly in 12-yd. side dump cars, and the trains (operated by the company's light-tank locomotives) run over the entire system of main and construction tracks, the movement on the former, being, of course, under control of the regular train dispatchers. This gives much greater freedom and flexibility of movement than if the work was divided between the railway company's equipment and the power company's equipment. All the dump cars are operated by compressed air, the dumping being controlled from the locomotive. Compressed air is used very extensively to operate hoisting and other engines on the work, thus avoiding the use of numerous small boilers and consequent uneconomical use of fuel.

CONCRETE MATERIAL.—All cement is given a seven-day test at the mill, and is shipped in sealed cars to the plant, where it is again tested at the laboratory. More importance is attached, however, to the tests of the mortar, in order that it may be seen whether this is being made properly and economically. At the concrete mixing plant, samples of the mortar are taken every morning and afternoon, and tested at once as to proportions. Briquettes are made for future tests at seven days, and at 3, 6, 9, 12 and 24 months.

The stone for concrete for the main dam is obtained from a quarry adjacent to the construction plant of the Illinois division. For the concrete of the power house work, the stone will be obtained from excavations for the foundations of its substructure and for the tail race.

The sand is obtained from the Des Moines River, at the point where it enters the Mississippi, about two miles below the dam. Here is installed a floating sand-pump or hydraulic dredge, which pumps the sand through pipes to the storage pile, from which the water drains away. The delivery pipes are slung in A-frames on the

FIG. 15. CANTILEVER TRAVELER FOR PLACING CONCRETE.
(The steel forms and completed arches are shown; the openings being closed later.)

FIG. 16. CANTILEVER GANTRY CRANES FOR HANDLING ROCK AND CONCRETE AT THE POWER HOUSE WORK, AUG. 29, 1911.
(The mouths of draft tubes 1, 2 and 3 are shown in the face of the wall.)

pontoons, so as to deliver the sand at the desired height. On the storage pile, baffle boards are used to build up the bank, holding the sand and allowing the water to escape, as in the construction of embankments by the hydraulic method. A locomotive crane with a 2-yd clamshell bucket loads the sand into the dump cars for transportation to the bins of the concrete mixing plants.

COST-ACCOUNT SYSTEM.—A complete cost-account system is maintained, the distribution and analysis of expenses being done by one man, so that there is no conflict of opinions or ideas. This man also spends a good deal of time on the work, seeing that the force accounts, etc., are properly handled. Close records are kept also of the progress of the several parts of the work. For the labor-cost accounting, each man has a number, and each morning is given a time card, which he turns in at noon and at night for time entry. The card shows the man's number and name, the four times of starting and stopping work, his employment, and his rate of pay. It is endorsed by the foreman. The cards for each man for one month are kept in a rack, and a force of clerks attend to the distribution of accounts, pay rolls, etc.

LABOR.—The skilled labor is largely American, but the common laborers are mainly foreigners, who are found to be more reliable than Americans of the same class, and to give less trouble on account of drunkenness. All rock work is done by a special force of French-Canadians, who do no other kind of work. With the foreign common labor, special care is taken that the men are properly treated, and each man is paid his money direct, the system of having men in charge of "padrones" or so-called "interpreters" (who make all arrangements and collect all wages for certain groups of men) not being allowed. One result of this is that many of the skilled and unskilled laborers, as well as gang foremen, etc., remain permanently with this engineering firm (which does its own construction work) going from job to job.

The Americans are left to find their own quarters in Keokuk or Hamilton. The foreigners (mainly Italians and Austrians) are housed in bunk houses which are built by the company and let to the men for a small rental. The men provide their own food and cooking. Each bunk house accommodates 16 men, and is provided with running water and electric light. Watchmen are provided to keep order and a doctor in Keokuk acts as the company's medical officer; he visits the work and the two camps, inspects the men and sees that proper sanitary conditions are maintained. He has an office on the work, with a man in charge who is kept advised of the doctor's movements, so that the latter can be called by telephone at any time. At each camp there is a room with necessary instruments and appliances for dressing wounds and attending to any emergencies. Swamp lands and waterholes near the work are sprinkled with oil to prevent trouble from flies and mosquitoes.

One reason for the rapid and systematic progress of the work is the organization of the labor. One lot of men does nothing but place concrete, and consequently become very expert at this. On the form erection, certain men do the bolting and unbolting, others the placing of panels, etc. The working day is of 10 hours: 7 a. m. to noon and 1 to 6 p. m.

Construction Plant: Illinois Division.

The outfit at the east end of the work (for the main dam) is all grouped close to the end of the dam, and its arrangement is shown in Fig. 17. It includes a quarry, stone-crushing plant, concrete mixing plant, a power plant supplying the compressed air and electricity, machine and carpenter shops, storehouses for cement and other materials; also the traveler for placing concrete, three other travelers, eight 18-ton locomotives, two 90-ton steam shovels (one in the cofferdam and one at the quarry), derricks, dump cars, etc. There are also the offices for the engineers and superintendents, and a cement-testing laboratory.

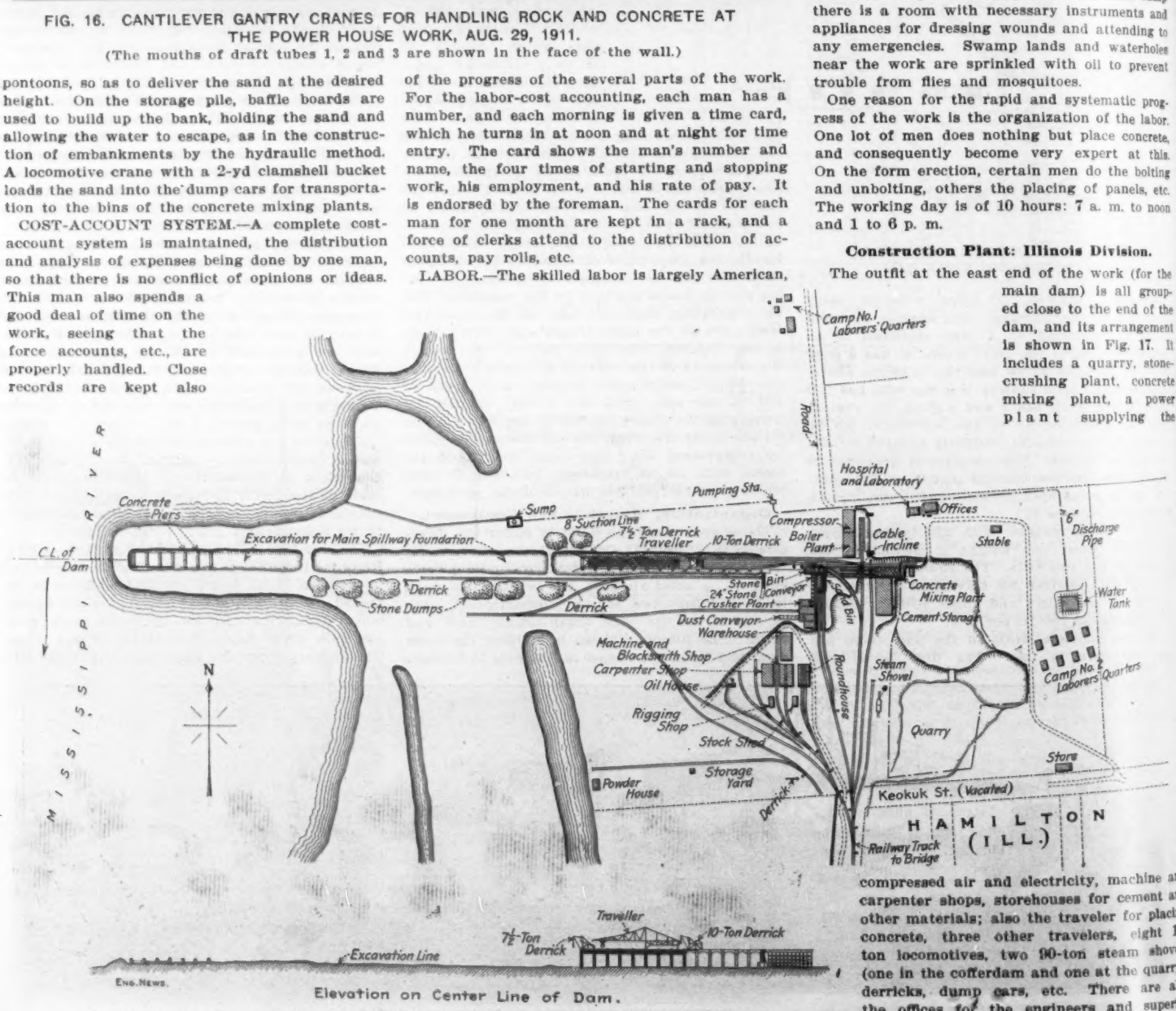


FIG. 17. PLAN OF CONSTRUCTION PLANT AT THE ILLINOIS END OF THE DAM.
(For work on the main dam.)

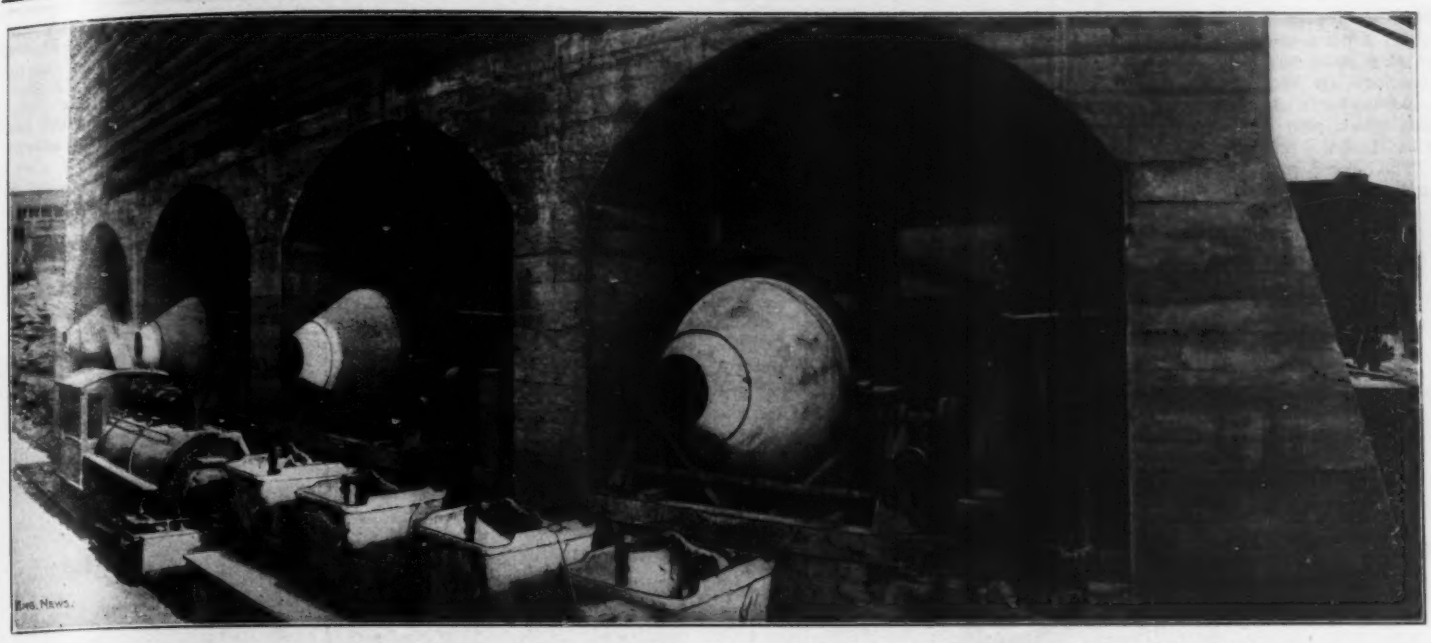


FIG. 18. CONCRETE MIXING PLANT FOR THE MAIN DAM OF THE MISSISSIPPI RIVER POWER CO. (ILLINOIS END).

(The four mixers are in a concrete structure which supports the timber bins for sand and stone. A horizontal air cylinder attached to the roof of each chamber operates the gate of the measuring chute for sand and stone. The mixers are driven by compressed air in summer and by steam in winter. Directly behind the mixers is the cement shed, the cement (in sacks) being trucked from cars on the storage floor to the mixers. The mixers discharge the concrete directly into the 1½-yd. drop-bottom buckets which stand on flat cars. The train is run out to the dam, where trolley hoists on a cantilever traveler pick up the buckets and carry them out to the point where concreting is in progress.)

Water pipes, with hydrants, are laid around the plant for fire protection.

The stone is obtained from a quarry about 300 ft. from the dam. When the 8 ft. of stripping is removed by steam shovels, two well-drills put down 5½-in. holes 38 ft. deep, the holes being 15 ft. apart and 20 ft. from the face of the quarry. A row of holes is charged with 60% gelatine dynamite, and all the holes are shot simultaneously by electric fuses. The rock is loaded by a 90-ton steam shovel into 12-yd. dump cars. The entire quarry force consists of 15 men, and the output of stone is about 700 yds. per day. As the work advances, the excavation of the foundation trench will supply a large amount of the stone for the concrete.

For the present work on dry land, the excavated rock is loaded by hand into skips handled by stiff-leg derricks (operated by air), which dump the skips into cars. For the excavation in the river, which is being done within a cofferdam, the rock will be loaded into cars by steam shovels.

There are two gyratory crushers, the larger one (No. 10 size) being fed directly from the dump cars, and having a hopper of such size as to take the largest of the quarry rocks. The product of the crusher passes to a revolving screen which separates the 4½-in. stone for the concrete; this is carried by an inclined belt conveyor to a storage bin. The dust and screenings are carried to a waste pile by a belt conveyor; the oversize rejections go to the small crusher, whose product is delivered to the inclined conveyor. Adjacent to the stone bin is another bin for sand, the sand (from the Des Moines River) being dumped into it directly from the cars. These bins hold about 500 cu. yds. of stone and 400 cu. yds. of sand.

The concrete mixing plant (Fig. 18) is higher up on the hillside, and consists of a concrete structure for the mixers, with timber bins above holding 700 yds. of stone and 500 yds. of sand. The stone from the lower storage bin is fed into two 5-yd. drop-bottom dump cars running on two tracks of a cable incline, one car descending as the other ascends. The incline extends over the upper bins, and the cars are dumped automatically when they reach the top of the incline. A single car on a third track conveys sand from the lower to the upper sand bin. The difference in elevation of the bottom and top of the incline is about 70 ft. The cement (in sacks) is delivered by the railway cars at a storage shed (of 40,000 sacks capacity), whose floor is level with and directly behind the operating floor of the mixer plant. The sacks are trucked either to storage or directly to the mixers.

The concrete structure for the mixing plant has four arched openings, in each of which is a mixer of the drum type, of 1½ yds. batch capacity. Just above the mixer is a floor on which are the cement hopper and the measuring chutes from the stone and sand bins above. The gates of these chutes are operated by compressed air cylinders, but the gate of the cement hopper is operated by hand. The proportion of stone is a fixed quantity, but the proportion of sand can be varied slightly (to suit the size of the stone) by means of turnbuckle and screw attachments on the operating levers. Water is supplied from a barrel fitted with a measuring gage. One man operates the gates of the measuring hoppers, handles the water valve, and starts and stops the mixer. The cement is emptied from the sacks directly into the hopper, where it requires to be stirred with a paddle to make it run quickly to the mixer. The men handling the cement wear respirators, covering nose and mouth, as a protection against the dust. Each mixer is driven by a vertical engine, which is operated by compressed air in summer and by steam in winter, the exhaust steam being then required to heat the sand and water.

In front of the mixing plant is a track, level with the top of the dam and below the level of the mixers. On this run the concrete trains, each consisting of four or five four-wheel flat cars, each carrying two 1½-yd. drop-bottom buckets. The mixers dump the batches of concrete directly into the buckets, and the train is then run to the traveler already described, when the

FIG. 19. BUILDING FORMS FOR DRAFT-TUBES, IOWA DIVISION, AUG. 11, 1911.

buckets are picked up and carried out to the point where concrete is being deposited. The mixing plant has a capacity of 1,200 cu. yds. of concrete per ten-hour day, and the amount of concrete for this part of the work will be about 200,000 cu. yds. About 500 men are employed on this Illinois work.

The power plant has a cross-compound two-stage air compressor, with a capacity of 2,500 cu. ft. of free air per minute at a pressure of 115 lbs. This is used to operate drills, pumps, derricks, stationary engines, shop equipment and the engines of the concreting traveler. Coal is brought in by railway cars and dumped into a stock pile directly behind the firing floor of the boilers.

Construction Plant: Iowa Division.

The working plant for the construction of the power-house and lock, includes four gantry cantilever cranes, steam shovels, derrick cars, and ten locomotives (eight 20-ton and two 40-ton engines). There is a power-house also, and a material yard, roundhouse, repair shop, etc. A plan of the construction plant and material yard is shown in Fig. 20. As the bluffs on this side come close to the river and there is only a narful steam shovels into skips; these are picked up by the travelers or gantry cranes spanning the excavation, as already described, and dumped into cars on tracks under the cantilever ends of the cranes. These crane tracks and car tracks are at the level of the river bed and the future floor of the forebay. The upper part of the rock is dumped outside the cofferdam, while the good rock is taken to the concrete plant.

The concrete plant is at the upper end of the enclosure. The main crusher is set in a deep pit, so that its top is a little below the exposed surface of the river bed (or future floor of forebay) and the cars dump rock directly into it. A pan elevator delivers the stone to a screen, the rejections going to a smaller crusher and the screenings to a waste bin. A conveyor delivers the crushed stone to a 1,200-yd. bin over the crushers, and sand is delivered to an adjacent bin by a similar apparatus. At the side of the bin is the cement shed, served by a spur track. The five concrete mixers are placed in the arched openings of a concrete structure which supports the sand and stone bins, and the mixers are at such an elevation as to deliver directly into the concrete buckets on flat cars at the level of the river bed. The cars will be run under the gantry cranes, whose trolleys will pick up the buckets and deliver the concrete.

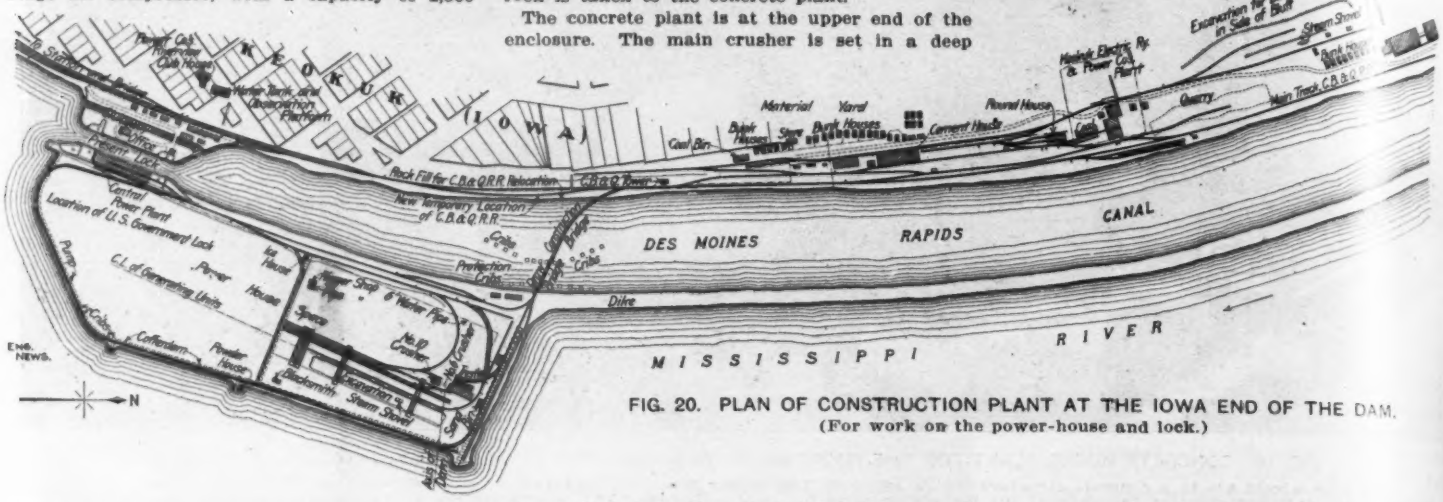


FIG. 20. PLAN OF CONSTRUCTION PLANT AT THE IOWA END OF THE DAM.
(For work on the power-house and lock.)

row strip of land between the railway and the river, the above facilities are strung out along the river instead of being grouped compactly as on the Illinois side. The power plant has two compressors of 350 HP. and 150 HP. which furnish air at 150 lbs. pressure for transmission to engines, drills, etc. There are also repair shops with machine tools, steam hammer, forges and other iron and wood-working machinery. There is also an electric-light plant for the offices and yards, and to enable the construction work to be carried on at night if this should be necessary. Water for domestic supply, fire protection and general purposes is supplied by a steel water tower of 100,000 gals. capacity, to which water is pumped from the canal.

The work to be done here includes about 200,000 yds. of excavation and the placing of about 340,000 yds. of concrete. The full working force will compose 1,100 men.

The deepest excavation will be for the draft tubes, and this will be 24 ft. deep. The loose rock broken up by blasting is loaded by power-

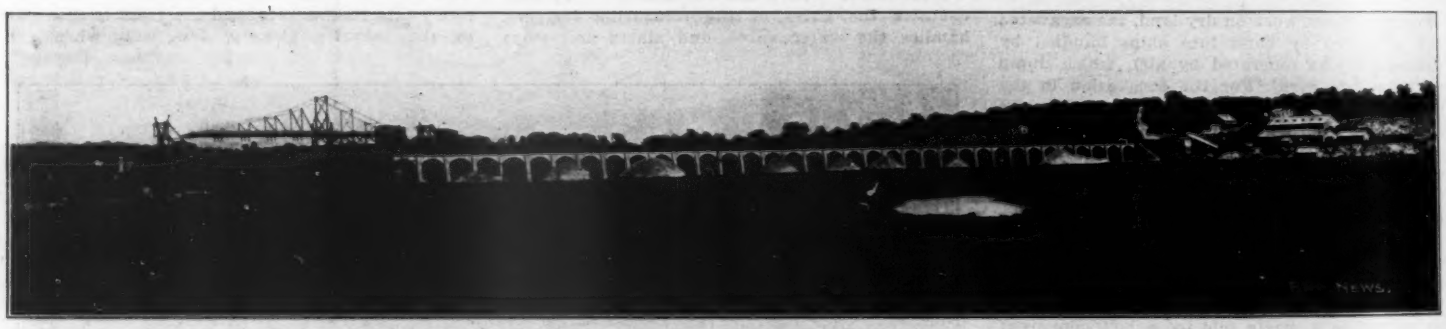


FIG. 21. VIEW SHOWING PROGRESS OF DAM CONSTRUCTION ACROSS ILLINOIS BOTTOM LAND, AUG. 29, 1911.

Rates for Municipal Street Lighting have recently been fixed by the Massachusetts Gas and Electric Light Commissioners for the town of Plymouth. The town Selectmen complained of the quality and price of electricity supplied by the local company. There were originally 327 25-c.p. carbon-filament lamps, three 32-c.p., and eight "1,200-c.p." arcs. All the incandescents were operated in a midnight-moonlight schedule and all except one arc, which was lighted all night. The charges were $20 per year for the 25-c.p. incandescent, $21 for the 32-c.p., $85 for the midnight-moonlight arcs, and $125 for the all-night arc. The old equipment was changed with the consent of the town, to 336 50-watt tungsten incandescent lamps, three 250-watt, and eight clusters of five 50-watt. These are all on a midnight-moonlight schedule except one cluster. The service was still billed as before, however, the charge totaling $7,313. The Selectmen contended (1) that the price for incandescent lamps was too high in comparison with that in other towns; (2) that the price for the lower-watt tungsten lamps should be lower than for carbon lamps, in spite of higher candle-power; (3) that the price for street lighting was too high in comparison with rates to private customers, and (4) that the price should be based on the expected consumption of energy as for one large customer at the average of the company's various rates or in accord with the general commercial schedule. The company contended that candle-power was the true measure of service value and the basis for price. Neither party offered the cost-and-investment basis. The Commissioners in deciding the case rejected the candle-power basis for that of energy supply and held that the rates should be as advantageous as offered to private customers. The Commissioners did not agree that the town should be considered as a single customer, on account of the scattered location of the lamps. The company was found to have paid only two dividends, aggregating 3%, since organization, there being a considerable burden of debt representing unliquidated depreciation, now fairly to be paid out of earnings. When such indebtedness is reduced, the Commissioners held, the rates will be reduced. The earnings of the company did not appear to be excessive, nor its financial policy open to criticism. The Board fixed the following schedule of prices: $16 per year for 50-watt tungsten lamps burning until midnight; $20 per year for 50-watt tungsten lamps burning all night; $71 per year for 250-watt lamps, or their equivalent clusters, burning until midnight, and $89 per year for 250-watt lamps or clusters burning all night. The total annual bill under this schedule amounts to $6,175.

The Construction Expenses of the Panama Canal, through the fiscal year ending June 30, 1911, are given as a supplement to the "Canal Record" of Aug. 9, 1911. The data include a statement of construction expenditures for the quarter, April-June, 1911, and for the entire work up to and including that period; and the last quarterly data on dam construction, locks and spillways construction, excavation, stone and sand production and concrete pile manufacture. The figures include both total and unit costs. A study of these shows that the unit costs have varied but slightly from those reported in detail up to September, 1910, in our issue of Nov. 24, 1910, p. 578. This would indicate that the operation of the canal work has now reached a very stable basis.

Causes of Some Failures of Creosoted Wood Block Paving in Chicago.

By C. K. MOHLER.*

Some months since the writer was called upon by the Loop Protective and Improvement Association to make a report on the use of creosoted wood block paving in the central business district of Chicago. After a somewhat thorough investigation of conditions, a report was made† favoring the use of creosoted wood block, with certain recommended changes in the specifications, etc. The following statements were made in the report:

A perfectly constructed and smooth, even-wearing surface of creosoted wood block may wear almost indefinitely.

The idea is to get as nearly a perfect rolling and wearing surface as possible, that will be maintained under traffic.

The aim should be to get the blocks so laid that they will remain exactly in the position in which they are placed, regardless of traffic movement, weather conditions, or temperature changes.

The use of fine sand for bedding (cushion) as well as too great a depth of sand was condemned. The poor methods and workmanship employed in laying the paving in and along the street railway tracks were pointed out and condemned. Attention was also called to the manhole frames and covers as evil factors in the way of securing and maintaining a perfect roadway surface.

The photographs reproduced herewith serve as proof that the criticisms were amply justified. They were taken about the end of July, 1911. Fig. 1 shows the wear that has taken place in less than two years where open joints were left between the blocks at points where tie-rods occur in the track construction. This wear is almost wholly the result of the calking of horses' shoes. It is questionable if the present method employed of beveling or cutting away a large part of the lower corner of the blocks of the closure course over a tie-rod, to give a close top joint, is much if any improvement. A considerable portion of the bed surface is cut away, and the space left by the beveled edge is probably never so completely filled that the blocks are thoroughly bedded. The closure required to fill out the tie-rod spacing is nearly always made with a course of fractional width, amounting in some cases to little more than a row of slivers. These are very serious defects affecting the appearance and durability of the pavement. The paving shown was so badly worn that repairing had been begun when the photograph was taken.

Fig. 2 (see title for explanation) shows pavement which had been done only a year. The above case is not exceptional, but is a condition that is almost universal. Rutting such as is shown outside of the rail to the right of the view will be found for blocks at a stretch. Fig. 3 shows an even worse portion of the same pavement, a short distance east of the portion shown by Fig. 2. The average depth of the rut shown a short distance from the rail is about 4 ins., while at the extreme right it is about 6 ins. The blocks are not only pounded down and broomed, but actually split and broken to pieces, and virtually destroyed.

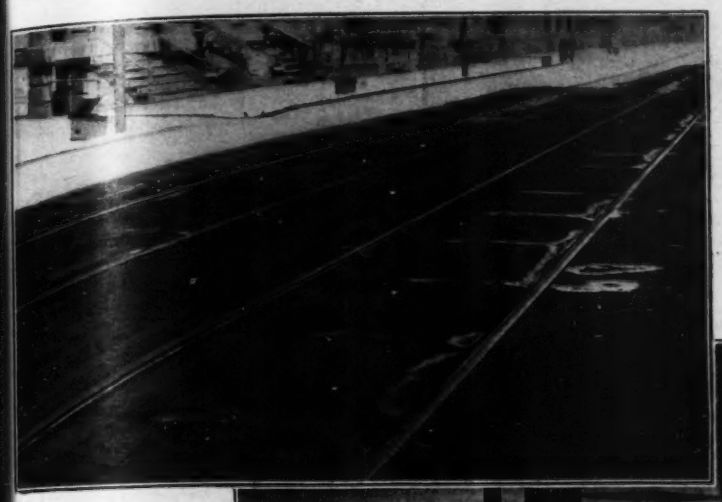


Fig. 1. Wear Due to the Action of Horses' Shoes at the Open Joints Left Where Tie Rods Occur in the Street Railway Track; Dearborn St., North of Adams St., Looking Northwest.

Fig. 2. Settlement and Rutting Outside the Rails, and Settling of Granite Block Paving Between the Rails: Randolph St., West of Clark St., Looking Southwest.

Many place may be found which are almost equally bad. Rutting about manholes is often found.

Unless some better methods are employed and more care is taken in laying creosoted wood block paving than has prevailed largely in the downtown section of Chicago, this kind of paving will gain a degree of unpopularity not deserved.

An absolutely secure foundation is the first essential. Relatively coarse sand should be used in the bed, and the sand bed should be of the least possible depth to secure a good surface. Probably the best method of bedding is the use of Portland cement with the sand bed. The bed can be wetted after the blocks are brought to a good surface, and the setting of the cement should prevent the possibility of the sand flowing or working out from under the blocks and allowing them to become displaced. Greater care should be taken in surfacing the sand bed before the blocks are laid.

Close attention to the above details should go a long way toward remedying any such defects as are shown in the accompanying views, which represent a rather general state of affairs chargeable to improper methods and faulty workmanship in laying.

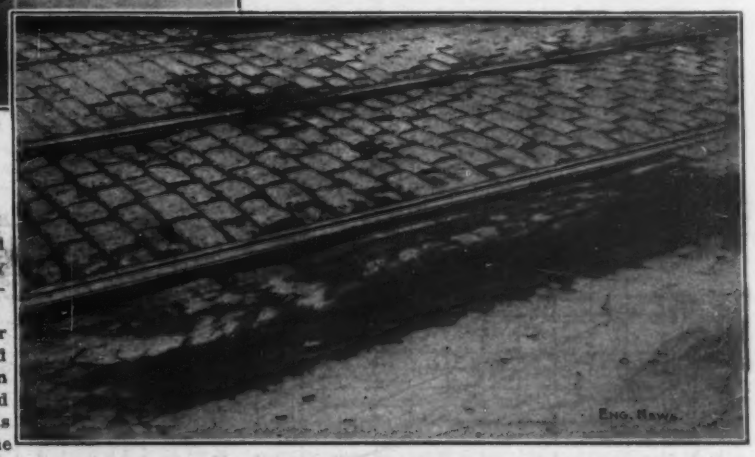


Fig. 3. Excessive Settlement and Rutting with Practical Destruction of the Blocks: Randolph St., West of Clark St.

FIGS. 1 TO 3. FAILURE OF WOOD BLOCK PAVING IN CHICAGO.

*Consulting Engineer, 234 N. Prairie Ave., Chicago.

†See "Two Reports on Chicago Paving," Eng. News, Aug. 31, 1911.

Municipal Ownership With Private Operation of the gas works of Paris, France, is described by Prof. A. N. Holcombe, of Harvard University, in "The Quarterly Journal of Economics" (Cambridge, Mass.) for August, 1911. A 50-year exclusive franchise held by the Paris Gas Co. having expired in 1905, the city purchased the company's equity in the plant in 1906. The French parliament being opposed to municipal ownership *and operation* the works were placed for a period of 20 years in the hands of what Professor Holcombe calls a "general operator," or a "public business manager, employed under a profit-sharing plan, designed to afford him an incentive to the exercise of the same personal initiative as under private ownership." Under this plan, known locally as "régie intéressée," as distinguished from "régie directe," the municipality prescribed the initial rates to be charged to private consumers, and is to share in the profits, and has the right to alter the rates as well as to regulate wages and the general conditions of employment. The operator of the gas works was selected as a result of competitive bidding, under prescribed conditions calling for a working capital of 30,000,000 francs (about $7,500,000) of which 5,000,000 francs were to be deposited as security. The conditions also required that the operator should pay all operating and maintenance charges and taxes; interest and sinking fund charges on loans made by the city to reduce the price of gas in 1903 and to buy the old works in 1906, together with like charges on future additional municipal outlays; also enough to ensure 5% return on the 5,000,000 francs put aside as security; and, in addition, 5% of the profits left after meeting these charges was to be put aside by the operating company as a reserve. All earnings above the aggregate of the items just stated were to be disposed of as follows: (1) the operator should be allowed 5% on 25,000,000 francs of its working capital, subject to deductions for failure to meet various contract requirements; (2) the operator would be entitled to a payment of 150,000 francs a year whenever it should appear that the city's share of the profits for the preceding year would have exceeded 20,000,000 francs for that year had the price of gas been reduced by ½ centime per cu. m. to cover that year. Should the net income to the city fall below 14,000,000 francs then the operator should be allowed only 4% instead of 5% on its 25,000,000 francs of working capital. (3) All profits above those provided for, as stated, were to go to the city. It should be added that the price of gas was fixed at 15 centimes per cu. m. of gas supplied to the city and 20 centimes for that furnished private consumers, but with not less than ½ centime per cu. m. reduction under the conditions named just above. (1 cu. m. = 35.3 cu. ft. and 1 centime = 2 cts. approximately.) There were 13 bidders under the terms outlined. Of these five offering equal advantages to the city entered into a second competition, under which an award was made to the bidder who offered to relinquish to the city the largest percentage of the supplementary profits arising from a reduction in gas rates. Neither what this percentage was nor results obtained since the operator assumed charge of the Paris gas works are stated by Professor Holcombe.

Tests of the Strength of Flat Steel Plates.[1]

By TANDY A. BRYSON.[2]

EXISTING THEORIES.—The formulas for the strength of flat plates given in the various text-books are not satisfactory. Most of them are the results of theoretical investigation not supplemented by actual tests. Perhaps the most widely quoted one is that of Grashof. Bach and Navier have also proposed formulas. The three formulas as applied to rectangular plates may all be written:

$$S = C a^2 \frac{p}{t^2} \quad \ldots\ldots(1)$$

in which C has different values according to each author. The symbols used are:

S = stress, lbs. per sq. in.,
p = load on plate (uniform), lbs. per sq. in.,
t = thickness of plate, ins.,
a = length of short side of plate, ins.,
C = constant depending on ratio of a to the long side b.

The values of C are:

according to Bach,[3] $C = \frac{c_1 b^2}{a^2 + b^2}$

according to Grashof,[4] $C = \frac{c_2 a^4}{a^4 + b^4}$

according to Navier,[5] $C = \frac{c_3 b^4}{(a^2 + b^2)^2}$

The following derivation, modified from that given by Morley,[6] gives the reason for the form of eq. (1) for supported edges. Referring to Fig. 1, let AC be a diagonal of the rectangular plate. The internal stresses in this section are in equilibrium with the external forces on either side of the section. The resultant reaction on the edge AB is at the middle point E since this reaction is symmetrical. For the same reason that of BC is at F. Hence the resultant of these two must be on the line EF which is parallel to AC and at a distance $\frac{1}{3}BN$ from it. The resultant of the hydrostatic forces is at the center of gravity of ABC or $\frac{1}{3}BN$ from the line AC. The stresses in the surface fibers along AC may vary; but for any differential length of AC, say dl, the stress is uniform and the moment of the internal stresses of this section is

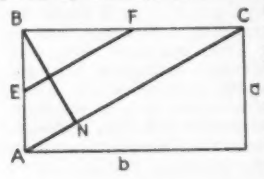


Fig. 1. Diagram of Flat Plate for Deivation of Approximate Formula.

$$dM = \frac{S\,dl\,t^2}{6}$$

The sum of these moments becomes

$$M = \frac{t^2}{6} \int S\,dl = KS_{max} \frac{lt^2}{6}$$

where $l = AC$ and S_{max} is the maximum stress in the plate. The moment of the reaction and hydrostatic forces of the complete half plate about the line AC is

$$\left(p \frac{ab}{2}\right)\left[\frac{1}{2}\overline{BN} - \frac{1}{3}\overline{BN}\right] = \frac{1}{12} p\,ab\,\overline{BN}$$

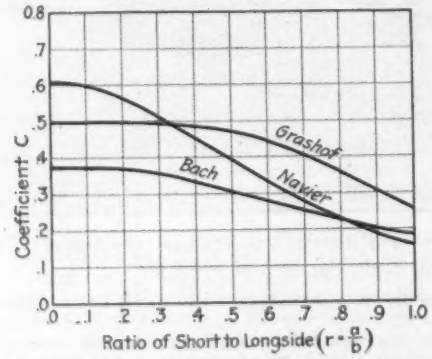


Fig. 2. Curves of Three Flat-Plate Formulas, Plotted on Base of Ratio of Sides.

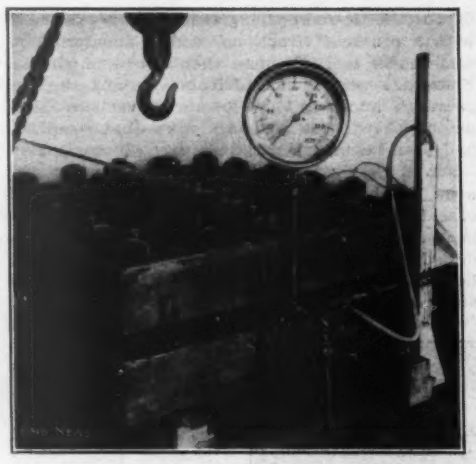


Fig. 3. View of Test Apparatus.

Now

$$\overline{BN} = \frac{ab}{\sqrt{a^2 + b^2}}$$

and

$$l = \sqrt{a^2 + b^2}$$

Hence for a supported plate

$$\frac{1}{12} \frac{pa^2b^2}{\sqrt{a^2 + b^2}} = \frac{K}{6} S_{max}\, t^2 \sqrt{a^2 + b^2}$$

or

$$S_{max} = \frac{a^2b^2}{2K(a^2 + b^2)} \frac{p}{t^2} \quad \ldots\ldots(2)$$

In the above formula K will have a value less than unity since the stress S is not uniform along the diagonal.

For a plate with fixed edges the moment of stress will be decreased since the negative internal stress moment at the edge is acting to support part of the load. For this reason K_1 (in place of K) may be greater than unity.

The formula (2) may be put in the form

$$S = Ca^2 \frac{p}{t^2}$$

Fig. 2 shows the values of C for fixed plates as given by the different authors. The variation shown by this figure as well as the fact that the formula of Grashof gives thicknesses greater than those used in practice led the author to make the experiments described below. The object was to determine whether or not the general form of the existing formula expresses the conditions obtaining in a plate of steel or other homogeneous material, and if so the probable value of the coefficient. The tests made for the design of the dry dock "Dewey," two plates broken by Galliott of the Department of Bridges and Roads in France, and four tests by Bach, were all the previous experimental data available.

TESTS OF STEEL PLATES.—In connection with this study eight tests were made. They were confined to square plates with spans 18 x 18 ins. and 24 x 24 ins.; thicknesses ranging from ⅛ to ½-in. The material tested was medium boiler plate, being the product of the Lukens Steel Co., of Coatesville, Pa. Fig. 3 is a photograph of the apparatus. Two plates were held between two square cast-iron frames, and water pressure was applied to the inner surface of the plates, a cast-iron distance-piece being used to separate the plates. The frames were held together by bolts not passing through the plates. Pressures from zero to 90 lbs. per sq. in. were obtained from the city mains, and higher pressures were secured by a hand force-pump. Packing of asbestos rope was used. Almost no trouble from leaking was experienced until a pressure of 225 lbs. per sq. in. was reached, when the distance-piece broke.

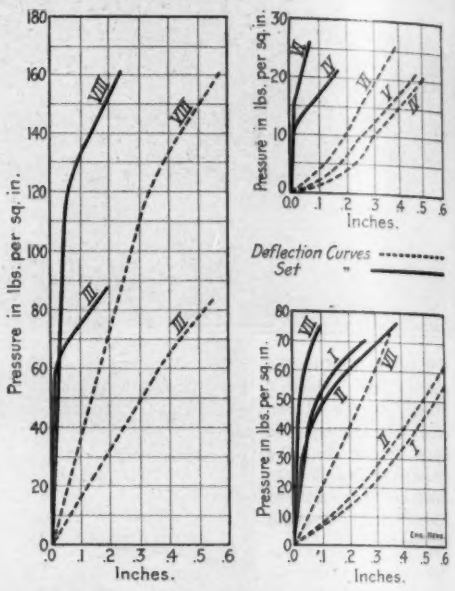


Fig. 4. Deflection and Set of Plates, Plotted Against Pressure.

Deflections were taken at five points across the center of the plate by means of micrometers reading to 0.001-in. Contact was determined by an electric buzzer. Pressures above 5 lbs. per sq. in. were measured by one of two calibrated gages of 160 and 3,000 lbs. capacity. For the lower pressures a mercury U-tube was employed. The thickness of the plate was determined from its area and weight. The value used for the specific gravity was that adopted by the Association of American Steel Manufacturers. The plate thickness was checked by a micrometer at several points.

The plan was to determine first the physical constants of the material. This was done by cutting a test-piece off the edge of each plate. An autographic machine was used and the elastic limit, ultimate strength, elongation and reduction of area were found. The coefficient of elasticity and the elastic limit of a specimen of the same lot of metal were accurately determined by micrometer measurements.

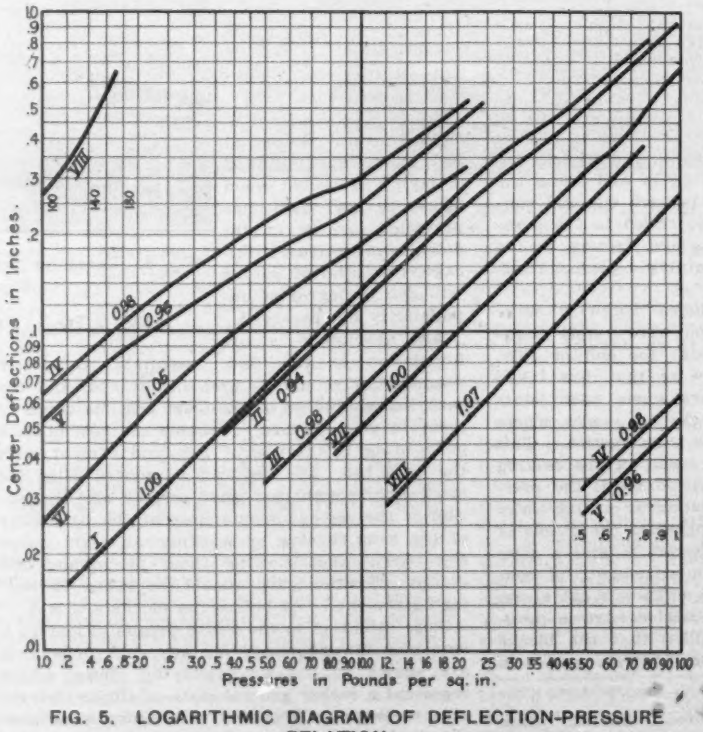


FIG. 5. LOGARITHMIC DIAGRAM OF DEFLECTION-PRESSURE RELATION.

[1]Abstracted from Bulletin No. 2, Engineering and Science Series, Rensselaer Polytechnic Institute, Troy, N. Y., entitled "The Strength of Flat Plates." The paper was based on a 1910 thesis by the author, for which he received the Macdonald Prize.

[2]132 Sumac St., Wissahickon, Philadelphia, Pa.

[3]Merriman, "Mechanics of Materials," 10th ed., p. 410.

[4]Lanza, "Applied Mechanics."

[5]"American Machinist," Oct. 10, 1901.

[6]"Strength of Materials," Morley.

In the bulging tests the deflections were taken at each increment of load, and after each increment the load was removed and the set noted.

The center deflections of plates under load, and the set with load removed, were plotted against true hydrostatic pressures (Fig. 4). The small set apparent even under small load was probably due to the excessive stress at the corners of the plate. From these curves the pressure at the elastic limit was determined, being the point at which the set curve changes its inclination.

To obtain values for the coefficient of formula (1), the value of the stress at elastic limit, as determined from the tensile test, was put for S and the pressure at the elastic limit, as found from the set curves, for p. Knowing t and a the expression was solved for C. The resulting values of C are given in the table below.

The uniformity in the value of C with such large variations of the ratio of span to thickness as well as in the span shows that the form of expression used is close to the truth, and that such a formula may be accepted for steel plates fixed at the edge. The stress at the elastic limit is practically constant for all specimens, so that the uniformity in C is not affected by the term S. If a different material is used, in which S differs from that for steel, the physical properties and the behavior of the substance under stress would give a different value of C. Thus, Moody has found for cast-iron the value of C to be 0.09 for square plates. The formula recommended for square plates of soft steel is, therefore:

$$S = 0.141\ a^2 \frac{p}{t^2}$$

To find a formula for deflection, the deflections were plotted on logarithmic paper as a function of the different variables p, a and t, when only one of these quantities varied. From the curves so obtained the following formula was derived:

$$d = 0.000{,}000{,}0516\ p\ \frac{a^3}{t^{2.1}}$$

This formula is only approximate within the elastic limit, for the ratio of the logarithms of deflection and thickness was not found to be constant when pressure and thickness varied. As the deflection increased the exponent of t decreased. This is probably due to suspension stresses.

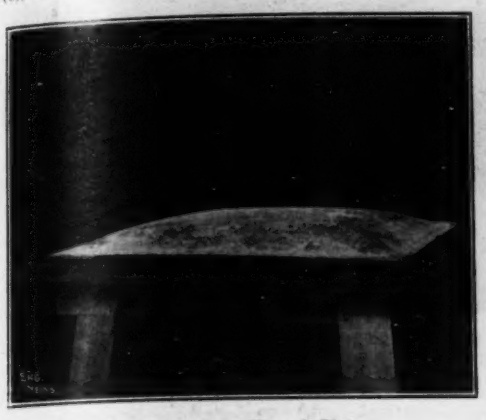


Fig. 6. Bulged Profile of Plate.

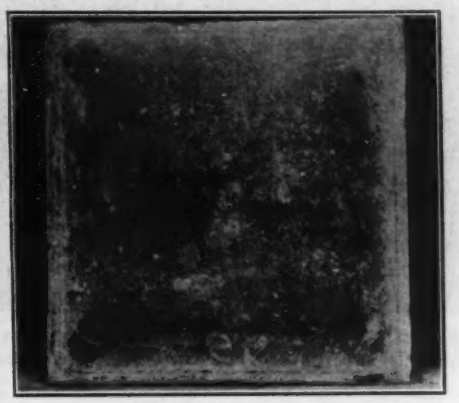


Fig. 7. Appearance of Convex Face.

Fig. 8. Appearance of Concave Face.

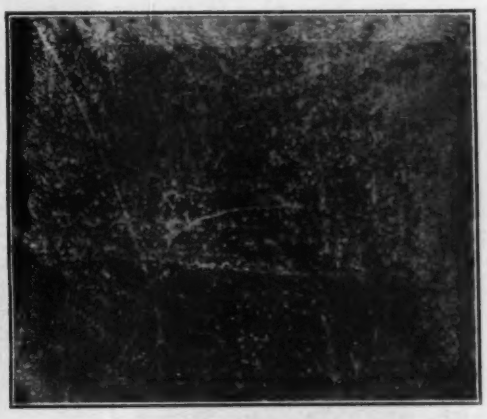


Fig. 9. Larger View of a Part of Concave Face.

FIGS. 6 TO 9. VIEWS OF A PLATE AFTER TEST.

COEFFICIENTS OBTAINED FROM TESTS OF SQUARE FLAT STEEL PLATES.

Test No.	Thickness of plate, t, ins.	Side of square a, ins.	Hydrostatic pressure applied, lbs. per sq. in. Max.	Hydrostatic pressure applied, lbs. per sq. in. At El. Lim.	Elastic limit stress, S, lbs. per sq. in.	Coefficient C
1	0.262	24	50	31.0	36,120	0.139
2	0.248	24	45	28.0	36,000	0.137
3	0.386	24	150	58.0	34,870	0.156
4	0.141	24	35	9.5	36,000	0.131
5	0.138	24	25.4	9.3	35,980	0.138
6	0.141	18	25.4	15.5	36,000	0.142
7	0.248	18	70	50.0	36,000	0.137
8	0.544	24	150	112.0	32,500	0.149
					Mean	0.141

An approximate expression for deflection when a flat plate is forced into spherical form and resists rupture by tension only (i. e., by suspension stress) is,

$$d = K\ \frac{a^{4/3}\ p^{1/3}}{t^{1/3}}$$

Thus in the bending of a plate, as suspension stresses come into play the exponents of t and p decrease, approaching 1/3 when the condition approaches that of pure suspension.

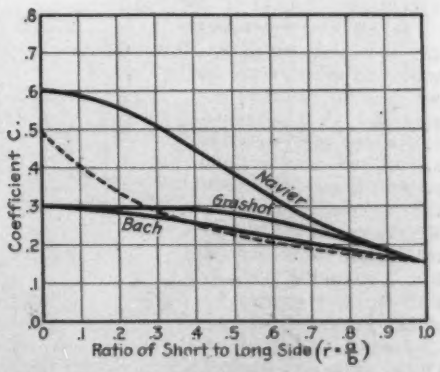


Fig. 10. Diagram of Recommended Values of C for Rectangular Plates, in Comparison with Prior Formulas.

While the tests gave a value of C for square plates (0.141), values for rectangular plates of different ratios of breadth to length had to be obtained from the formulas of Bach, Grashof and Navier. These formulas were plotted on a base of ratio of short to long side, Fig. 10, after reducing each formula in the proper proportion to give the value 0.141 for a square plate (ratio $a/b = 1$). For the ratio 0.5, two points were obtained from four tests of Bach.[1] Two of his tests were on square plates and two on rectangular plates. The value of C in formula (1) for his rectangular plates was found to be 1.40 and 1.50 times the value of C for his two square plates. On the basis of $C = 0.141$ for square plates, the C for the rectangular plates would be 0.197 and 0.212.

It will be seen that Navier and Grashof are rather high. Bach's curve agrees closely with the points plotted. However, at $r = 0$, where one side of the plate is infinitely long, the plate must act as a beam of span equal to the short side. The coefficient for beam action is 0.5 and for small values of r the coefficient should approach this value. For a plate in which $r = 0$, i. e., b is infinitely long compared with a, the support from the ends a is negligible and the plate practically acts as a fixed beam of span a and width b subject to hydrostatic pressure p per unit area, so that

$$\frac{1}{12}\ pabs = \frac{Sbt^2}{6}$$

$$\text{or}\quad S = \frac{6}{12}\ a^2\ \frac{p}{t^2} = 0.5\ a^2\ \frac{p}{t^2};\ \text{or}\ C = 0.5.$$

A curve satisfying these conditions at $r = 1$, $p = .5$ and $r = 0$ is shown dotted on the diagram. Its equation is

$$C = \frac{0.5}{1 + 2.55\ r}$$

in which r is the ratio of short to long side $= \frac{a}{b}$.

Substituting this in formula (1) we have

$$\text{Fixed edges}\left\{\quad S = \frac{0.5}{1 + 2.55\left(\frac{a}{b}\right)}\ a^2\ \frac{p}{t^2}\right.$$

While the author's tests were of plates with fixed edges only, it is believed that the results may be applied with small error to simply supported plates by multiplying the coefficient C by 1.5, as this is the ratio of stress in supported to that in fixed beams. This would undoubtedly err on the side of safety, since plates are rarely used as simply supported. The usual practice of riveting them to angles results in a condition neither fixed nor supported, but an intermediate condition depending on the deflection of the leg of the angle, etc., and the stresses at the edges and center of the plate may be so nearly equalized as to realize the maximum strength. Using a formula similar to the one for fixed plates there results:

$$\text{Supported edges}\left\{\quad S = \frac{0.75}{1 + 2.55\ \frac{a}{b}}\ a^2\ \frac{p}{t^2}\right.$$

Thus for square plates the values of C vary from 0.141 to 0.212 depending on end conditions. The values suggested by Professor Bach are 0.19 to 0.28.

It is believed that the above formulas are correct for thicknesses from 0.1 to 0.6-in., and for values of a/t from 50 to 150.

[1] Zeitschrift des Vereines Deutscher Ingenieure, Nov. 7 and 21, 1908.

Irrigation Statistics for Montana, compiled by the U. S. Bureau of the Census, show an increase of 11.5% in the number of farms irrigated in 1909, as compared with 1899, against an increase of 96.1% in the total number of farms during the same period, "indicating that dry farming had a more rapid growth than irrigation during the ten years." Expressed in acreage, irrigation showed greater advance than is indicated by increasing number of farms. The total acreage irrigated in 1909 was 1,679,084 acres against 951,154 acres in 1899. This was an increase of 76.5%, as compared with an increase of 109.6% of the improved acreage of farmland for the same period. The wide extent of irrigation in Montana is shown by the fact that 46.1% of the total improved farmlands in the State was irrigated in 1909. This, however, was a decrease, as compared with 1899, when the percentage was 54.8%. Classing irrigation works built by the U. S. Reclamation Service as belonging to the water users, as will ultimately be the case, "92.3% of the acreage irrigated in 1909 was supplied by works controlled by the water users." The relative acreages under different sources of supply in 1909 were as follows: Streams, 1,632,619 acres, or 97.2% of the total acreage irrigated; lakes, 5,622 acres, or 0.3%; wells, 262 acres, or 0.02%; springs, 17,967 acres, or 1.1%, and reservoirs, 22,614 acres, or 1.3%.

Portable Conveyors and Elevators for Handling Freight.

The use of portable conveyors presents many opportunities for economy and efficiency in the handling of freight at warehouses, stores, railway freight houses and steamship piers, etc. The portable conveyors and elevators described below have been used extensively in work of this kind, and have been adapted to ordinary and special conditions of work. The conveyor, shown in Fig. 1, consists of light steel truss frames 15 to 25 ft. long, each carrying a pair of endless link chains which pass over sprockets on end axles which also carry gear wheels for driving the shaft and chain. The chains are connected by cross bars fitted with rollers; with some kinds of freight (especially sacks and bales) these bars serve to move the packages, but for moving boxes and barrels arms or cross flights of suitable form may be attached to the chains. In some cases, also, a small platform is carried by each alternate pair of cross bars.

FIG. 1. PORTABLE CONVEYOR FOR FREIGHT, SHOWING TWO CONVEYOR SECTIONS AND A MOTOR SECTION.
(Brown Portable Elevator Co., Saginaw, Mich. Builder.)

The conveyors are driven by an electric motor or gasoline engine mounted on a portable carriage which is fitted with ball-bearing castors to facilitate its movement from place to place. When the end of the conveyor frame is fitted to supports on the carriage its gear wheels engage with gear wheels on the carriage. The conveyor sections are easily handled, attached and removed. Fig. 1 shows two sections attached to a carriage having an electric motor; additional sections may be added, each being driven from the adjacent section by the engagement of their respective gear wheels. The conveyor may be placed at any angle, and is so made that it will pick up a sack from the floor, which avoids the necessity of lifting the load and placing it upon the conveyor. A special feature of the system is that sharp corners can be turned. For this purpose a separate section is used consisting of a series of conical rolls, with gear wheels on their shafts. This is mounted on a wheeled frame or carriage supported on castor wheels, and is shown in Fig. 2.

One particular application of the conveyor is in the handling of freight between steamers and piers and between railway cars and freight sheds. This is effected in the manner shown in Fig. 3, where sacks of grain are being handled from a car to a freight pier; as the load is removed the end of the conveyor is lowered till it rests on the floor of the car. A horizontal length of conveyor may be placed on the pier side of the carriage to carry the sack to a ship or to a storage pile. In this case, the carriage has a gasoline engine to operate the conveyor. In loading or unloading ships, an inclined length of conveyor may extend from the pier to the deck, a horizontal section across the deck to the hatch (very much as in Fig. 3), and a third section, set at a steep angle, would extend down into the hold. In this way ship's cargo may be handled more rapidly and with less damage than when handled by slings and cargo winches. Several machines of this kind are in use at Portland, Ore., and some are to be installed by the Chicago & Western Indiana R. R. at its freight shed and steamer pier on the Chicago River for transferring freight from cars to steamers. This equipment will include 133 ft. of conveyors, with three driving carriages having 5-HP. motors; it is intended to carry packages of about 280 lbs. weight.

Another application of this portable conveyor is as an elevator or stacker, and in fact it was originally designed for this class of work (in 1902). On the Pacific coast, grain is largely put up in sacks at the time of threshing, and the sacks are then hauled to a shipping point and stacked in warehouses until the time of shipment. The amount of grain handled annually in this way is said to be about 50,000,000 bushels. The device has been used very extensively for this particular kind of work, and has been applied also to general warehouse and other work, and may be built to handle any kind of packages. With hand labor in stacking the grain sacks (in tiers five sacks in height) two men are required for the first tier and two additional men for each additional tier. Thus with five tiers and loading 100 tons in each tier in a ten-hour day, or 500 tons in all, the labor cost (at $3 per day) would increase from $6 for the first tier to $30 for the fifth tier, with a total cost of $90, or 18 cts per ton. These figures are said to be from actual warehouse work. The machine could handle one ton per minute or 600 tons per day. Only four men are required; one to load the machine, two to pile the sacks, and one extra man. Allowing one hour for moving the machine, and allowing 75 cts. for power, the work would be 540 tons at a cost of $12.75, or 2.36 cts. per ton.

The elevator resembles the conveyor, but is attached to the carriage on which is the motor or engine, and it can be raised or lowered (by power) so as to be set at the proper angle to reach the desired height. A 35-ft. elevator with electric motor is shown in Fig. 4, while Fig. 5 shows a 28-ft. elevator used for stacking hay at the Chicago stock yards. In this case, it enabled the company to dispense with 11 men formerly required to stack the bales by hand. The Oahu Ry. & Land Co., of Hawaii, uses four of these machines for stacking sugar (in sacks); formerly it took 18 men to pile 6,500 sacks per day, while nine men now stack 7,000 per day. The advantages are still greater with wool sacks, which weigh as much as 600 to 700 lbs. each. In one case, where grain was brought down the Snake River in steamboats three elevators in series were used to elevate the sacks from the landing stage to a freight platform at a railway track higher up the bank. The machines are built in different sizes, handling one to three tons per minute, elevating to heights of 15 to 30 ft., and carrying loads of 100 lbs. to 800 lbs. each. The elevator is operated by a motor or engine of 2 to 5 HP. The smaller machines weigh about 900 lbs. with motor, or

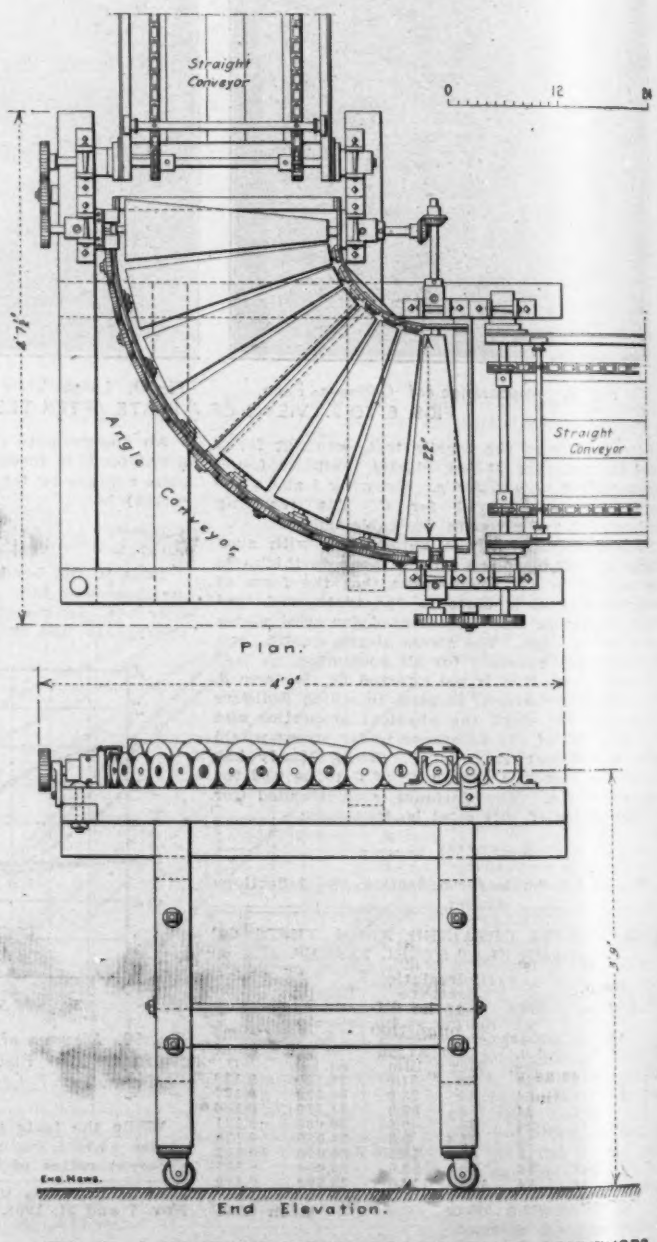


FIG. 2. A RIGHT-ANGLE TURN FOR PORTABLE CONVEYORS.

1,400 lbs. with gasoline engine; the others weigh from 200 to 300 lbs. more. The elevator has been adapted to the handling of loose material, such as sand and gravel, by fitting pans or buckets to the cross bars.

These portable conveyors and elevators were invented and patented by Frank H. Brown and Fred H. Brown. They are built by the Brown Portable Elevator Co., of Saginaw, Mich., and Portland, Ore., and the company has offices also at Chicago, Ill.

A Study of the Relative Number of Bacteria in Red Lake River in Winter and Summer.

Many winter outbreaks of typhoid fever have been attributed to the fact or possibility that winter conditions are more favorable to the life of typhoid bacteria in surface water than are the corresponding summer conditions. To throw further light upon this subject, Dr. Gustav F. Ruediger, Director State Public Health Laboratory, University of North Dakota, Grand Forks, N. D., recently made some studies of Red Lake River, Minn.*

The river named is the source of water-supply of Grand Forks, and is polluted with the untreated sewage of Crookston, Minn. (about 7,000 population), distant 80 to 90 miles by river and also distant by estimated stream flow time some 48 hrs.

FIG. 3. PORTABLE CONVEYOR UNLOADING SACKS FROM CARS.

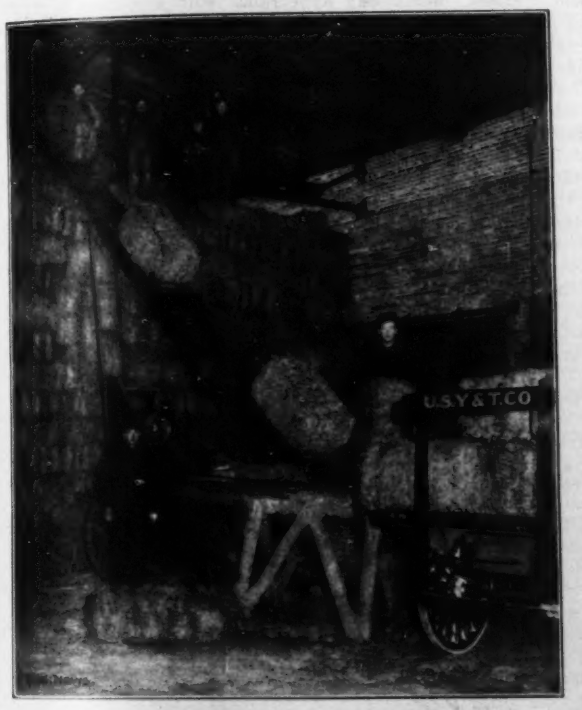


FIG. 5. STACKING HAY WITH PORTABLE ELEVATOR AT THE UNION STOCKYARDS; CHICAGO.

At Grand Forks six samples of river water were taken when the river was not covered with ice (summers of 1909 and 1910), and two when the river was so covered (winter of 1910). The winter samples were taken when the ice averaged 30 ins. in thickness. After adjusting the samples to correspond to the relative volume of stream flow at the different seasons, it was found that the water contained "from four to five times as many B. coli per cc. during the winter months as it does during the early part of the summer." The pollution of the river at Crookston is said to be "approximately the same all the year round, and hence this difference in the number of B. coli must be due to a more rapid destruction of these organisms during the summer months."

In continuation of these studies, dialysers were floated down the river from Crookston to Grand Forks after having been charged with 25 cc. of polluted river water and ½ cc. of a culture of B. typhosus, containing about 166,000,000 organisms. The journey took 54 hrs. At its conclusion, only a small fraction of 1% of the original number of germs was found in the dialysers. These experiments were made when the river was not covered with ice. Subsequent experiments under similar conditions showed from 0.5 to 3.5% of B. typhosus remaining.

To find the effect of ice and other winter conditions, a number of dialysers were hung in the river under ice, and the results obtained therefrom were compared with dialysers hung likewise in the open, but in the summer instead of in the winter. The results of these experiments as reported were:

B. typhosus introduced	B. typhosus left.		
DIALYSERS HUNG IN OPEN RIVER.			
62,000,000	1,200,000	= 3.5 %	after 48 hours
62,000,000	1,274,000	= 2.5 %	after 48 hours
65,600,000	340,000	= 0.51%	after 72 hours
65,000,000	585,000	= 0.89%	after 72 hours
7,200,000	161,500	= 2.2 %	after 72 hours
7,200,000	232,900	= 3.2 %	after 72 hours
DIALYSERS HUNG IN RIVER UNDER ICE.			
410,000,000	128,000,000	= 31. %	after 3 days
410,000,000	78,000,000	= 19. %	after 7 days
410,000,000	10,037,000	= 2.5%	after 14 days
15,000,000	915,000	= 6.1%	after 2 days
13,000,000	1,365,000	= 10.5%	after 2 days
10,400,000	4,867,000	= 46.8%	after 2 days
190,000,000	4,867,200	= 17.7%	after 2 days
124,000,000	76,080,000	= 62.9%	after 2 days

All dialysers contained 25 cc. of polluted river water, to which were added typhoid bacilli.

The foregoing information is based on a paper read by Dr. Ruediger before the American Public Health Association in September, 1910, but published only recently in the "Journal" of the American Public Health Association. We give Dr. Ruediger's final conclusions as follows:

Colon bacilli and typhoid bacilli disappear much more rapidly from polluted river water during the summer months than during the winter months when the river is covered with ice and snow.

The destruction of these organisms in the river water during the summer months is in large measure due to the growth of microscopic plants and other organisms which apparently give off dialysable substances which are harmful to B. coli and B. typhosus. That such substances are given off by the saprophytic bacteria was clearly shown by Frost several years ago, and my experiments simply confirm his by attacking the problem in a slightly different way. These effects are lost in the winter, as no growth takes place at 0° C.

The direct rays of the sun are also an important factor, and their effects are entirely lost when the river is covered with a thick layer of ice and snow.

The practical value of this investigation is very evident. It explains why some of our northern cities where sewage-polluted river water is used in the water-works system are more frequently troubled with outbreaks of typhoid fever during the winter months. This was illustrated at Minneapolis last winter, and I believe was true at Lawrence, Mass., before the installation of the filter.

When bacteriological analyses of sewage-polluted river water are to be made at the site of a proposed water-works intake pipe, it is important that samples should be collected and analyzed both in the winter and in the summer. Analyses of samples collected during the summer do not give reliable information in regard to the condition of that water when the river is covered with ice and snow. My analyses show that the pathogenic bacteria from the sewage travel several times as far in the water under the ice before they are destroyed, as they will during warm weather in an open river.

FIG. 4. A PORTABLE ELEVATING CONVEYOR FOR STACKING FREIGHT IN WAREHOUSES.
(Brown Portable Conveyor Co., Saginaw, Mich., Builder.)

*Some portions of the same paper, dealing mostly with other phases of the subject, were given in our issue of Sept. 15, 1910, in connection with a report of the meeting at which the paper was read.

Deep-Hole Rock-Drilling on the New York State Barge Canal.

By LUCIUS I. WIGHTMAN.*

The deep-hole drills about to be described were built by the Ingersoll-Rand Co., of New York, to meet deep-hole drilling conditions on certain sections of the New York State Barge Canal.

In these drills, called "autotraction drills," the drill truck or carriage consists of a heavy timber frame mounted on flanged steel wheels running on a track of wide gage. Chain-and-sprocket and gear drive between the forward truck wheels and an independent reversing engine on the rear of the frame provides for the movement of the machine along its track from hole to hole. Over the forward wheels is a turntable about 8 ft. in diameter, which is rotated by means of a hand crank operating a pinion and outside gear on the circumference of the turntable. Clamping screws lock the turntable in any position desired. Built up on the turntable is the drill mounting or frame, of steel angles and channels rigidly braced. The base of this frame, made of two channel irons, extends forward beyond the turntable about 3 ft., and carries a heavy jack-screw which is run down to a block on the ground, giving rigidity to the drill rig when at work. The vertical members of the frame are channel irons which serve as guides for a heavy cast-iron block to which the drill proper is bolted; and this block is raised or lowered, with the drill, by means of steel cables passing over sheaves at the head of the frame to a drum below geared to a small reversing engine. In the particular drills here described, the weight, with the drill, has an up-and-down travel of about 16 ft. This travel or length of feed can be altered, when a machine is built, to suit the conditions under which it is to operate. In the present case it was necessary to provide only for holes 12 to 15 ft. deep.

The drill proper is a standard Ingersoll-Rand rock-drill, of "H-61" submarine type. Its cylinder diameter is 5½ ins., the stroke 8 ins. At 75 lbs. pressure it has a speed of about 250 blows per min. The machine has the standard features of "Sergeant" release rotation, cushion back-head spring, and U-bolt chuck. Air is supplied through a length of hose leading to a throttle valve placed within easy reach of the operator's hand, close to the lever controlling the feed engine. The drill and frame are so placed on the turntable that when the turntable is revolved the steel describes the arc of a circle 10 ft. in diameter, swinging to both sides of the machine.

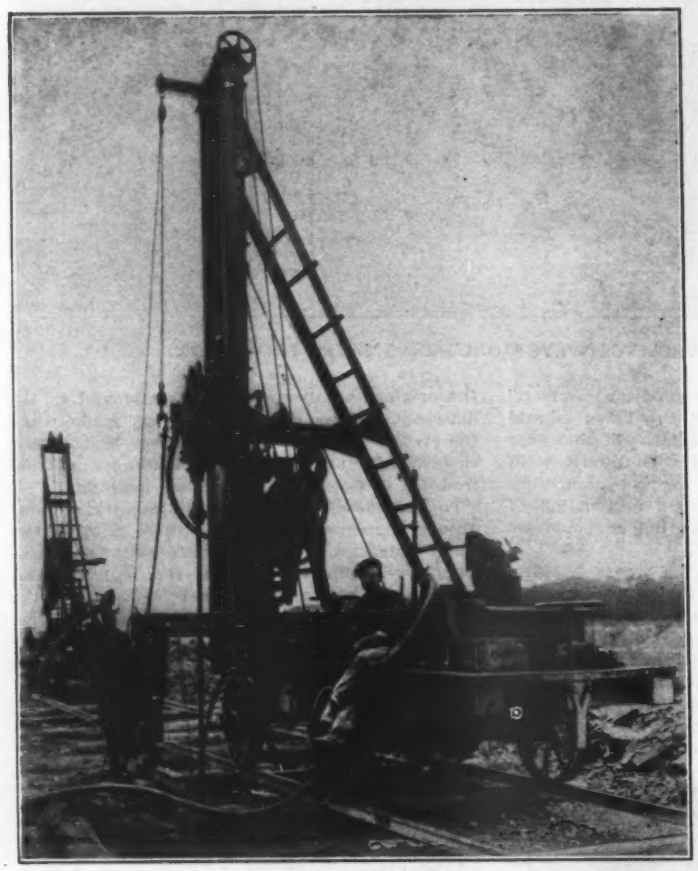


FIG. 1. TWO AUTOTRACTION DEEP-HOLE ROCK-DRILLS OF THE LOCHER TYPE.

(The propelling engine and gear can be seen at the right.)

A small water-pipe about 15 ft. long, with a hose connection, is swung from a block-and-tackle at the head of the frame, and gradually fed downward into the hole, as the steel descends. In the Barge Canal work, water at 20 lbs. pressure is piped all over the ground, and the drill pipe takes its supply from these mains. But a small direct-acting pump is mounted on the truck, by means of which water can be drawn from any pool or other source at hand and forced through the water pipe into the hole. Compressed air for the drill and engines is taken from air mains, laid over the work.

The work on which these drills are engaged is in Sections 68 to 72 of the New York State Barge Canal, on the Champlain Branch, running northward in the Hudson Valley from Troy through Waterford, Mechanicville and Stillwater. The contract at Waterford is in the hands of the Merion Construction Co. The Shanley - Morrissey Co., Inc., is the contractor for the divisions at Mechanicville and Stillwater. The canal construction in these sections consists in the deepening of a portion of the Hudson River channel to form a waterway for barge traffic 200 ft. wide and 12 ft. deep in the clear.

In the greater part of these sections excavation has been carried on by a method calling for the construction of cofferdams shutting off portions of the river channel, the space within being pumped out by centrifugal pumps. These portions vary from a quarter of a mile up to a mile in length, and in many cases the cofferdams extend from the shore to islands in mid-channel. The exposed river bed is removed to the proper depth and width by drilling and blasting, loading the muck by steam shovel, and hauling away the waste in dump-car trains by steam locomotives. In some places this method could not be applied, and the river bed has been drilled and blasted and dredged on to barges, by means of a combined submarine drill scow and dipper dredge. The completed work will afford a clear channel paralleling the river, adapted to the heavy-draft vessels contemplated for the Barge Canal service. At Stillwater a tying-up basin or harbor is being excavated between two islands, beside the canal channel.

The rock encountered in these sections is a black Hudson shale, hard and brittle in its bed but crumbling under the atmospheric action when exposed. It lies at an acute angle so that the river bottom, when exposed, presents a jagged, hummocky appearance with a surface so rough and irregular as to make transportation of any kind over it impossible without laying track or building roadways.

At the time of the writer's visit to the work, drilling operations were temporarily suspended on all sections except one at Stillwater. Between Mechanicville and Waterford, the bursting of a cofferdam had flooded the bed and forced the removal of all drills and steam shovels, while the dam was being repaired and the water pumped out. At Stillwater, below one of the completed locks, there were in operation two of the autotraction drills, two steam shovels, and one well drill. At this point the autotraction drills were working on the bench about 100 yds. ahead of the shovel. They were running on a single track, one about 50 ft. ahead of the other. The working gang consisted of a drill runner and two helpers for each machine, with two or three extra men for laying track ahead.

The method of operation may be briefly defined as follows: The turntable of each drill is swung

FIG. 2. GENERAL VIEW OF CHANNEL WORK IN THE HUDSON RIVER NEAR MECHANICVILLE, SHOWING AN AUTOTRACTION DRILL AND TRIPOD DRILLS AT WORK.

*29 Broadway, New York City.

with the drill frame at right angles to the track; the jack-screw is set and a hole is drilled. The steel is withdrawn, the turntable swung until the frame is parallel to the track and another hole drilled midway between the rails. The turntable is then swung to the opposite side and the third hole drilled. Thus three holes are put down from each position of the machine, two on a line at right angles to the track, 10 ft. apart, and one 5 ft. in advance of the others and on a line midway between them. The drill is then moved forward on its track 5 ft., bringing the center of the turntable over the last hole between the rails, and three more holes are drilled in the same arrangement. When the following drill has caught up with the first holes of the leading drill, both are moved forward 50 ft. and started anew. This gives a triple row of holes 5 ft. on centers each way. When the needed length has been covered, drills and track are moved and another triple row of holes paralleling the first is put down. The steel used is solid, 2 ins. in diameter, 15 ft. long, terminating in a 4-in. crossbit. It makes a 4-in. hole 12 to 15 ft. deep as required. The water jet in the hole flushes out the cuttings and gives the bit a clear face to work upon.

One hole was timed and was put in 15 ft. deep in 12 mins. The drill-runner stated that his regular performance with his machine was from 160 to 200 ft. of 4-in. hole per 8-hr. shift. The best record on the work, under test conditions, was 165 ft. of 4-in. hole drilled in 4 hrs.

In operation, the drill-runner stands on the turntable, with the throttle valve and feed engine lever before him. The hole is started on short stroke in the usual way. The runner watches the drill and feeds the weight, with its drill, downward just enough to give full stroke without striking the heads. The weight of the cast-iron block absorbs the recoil of the drill. One man tends the water jet, lowering the pipe with the steel. The third man keeps the mouth of the hole clear, watches the jack-screw, and otherwise assists. As soon as a hole is finished, a wood plug is dropped in to keep it clear until ready for loading.

It will be observed that the 15-ft. hole is put down without change of steel, and three holes are drilled from a set-up. The number of holes which can be drilled with a steel varies with the tempering the smith has put in the bit. A poor bit may last only one hole. Well tempered steels will put in seven or eight holes. The average was three or four holes drilled per steel. The trouble is less in the dulling of the steel than in its loss of gage, so that later holes are of smaller diameter. This emphasizes the importance of careful attention to the smith shop when rapid, economical drilling is sought.

The view Fig. 2 shows standard tripod drills working near the autotraction drills. A large number of these are employed on portions of the work. They are of the "Sergeant F-24" type, with 3½-in. cylinders, and in the illustration are putting down 15-ft. holes. But they suffer under the handicap of steel-changing and loss of time in moving, which limits the tripod drill; and it has been found that one autotraction drill does the same work per day as seven of the tripod drills. A well drill machine working nearby was averaging 80 to 85 ft. of 4-in. hole per day. It was the only machine of the type on the work.

While the performance of the autotraction drills has been eminently satisfactory, it is believed that better results still will be secured by the adoption of the Locher pump drill-steel.*

Mr. C. H. Locher, of Thorice, Michigan, who invented this steel, is also the pioneer in the development of the deep-hole drilling machine of the general type here described. On the work of the contracting firm of Grant, Smith & Co. & Locher on the Livingstone Channel of the Detroit River, he devised an autotraction drill capable of putting down a 5-in. hole 50 ft. deep at a rate far better than any realized up to that time.† This machine was of course experimental and somewhat crude, requiring changes of steel every 8 ft., but it contained the proper idea, and Mr. Locher has developed it through successive models to a degree of remarkable speed and efficiency. The inventor's later work was carried on in connection with the Ingersoll-Rand Co., and the perfected auto-drills just described were produced under collaboration of Mr. Locher and the company's engineers, the inventor having licensed the company under his patents.

The Shanley-Morrissey Co. has eight of these autotraction drills on their work at Mechanicville and Stillwater, and four additional machines are on order. The Merion Construction Co., at Waterford, use one autotraction drill.

It is to be understood that the machines here described were specially designed and built for these local conditions. These drills can be made for all classes of work. The depth and diameter of hole, character of rock to be drilled, spacing of holes, etc., all have vital bearing upon some features of construction. They may carry an air reheater, or be fitted with a steam boiler where necessary. The general design and method of operation, however, are as just described, in all the autotraction drills built by the Ingersoll-Rand Co. Patents are either issued or pending on the essential features of these machines, in favor of that company. Several deep-hole autotraction drills of this general type have been built for Mr. Locher's own work, and are in operation at Grosse Isle. Others are on order for use on some sections of the Catskill Aqueduct of the New York Water Supply, and on the Barge Canal.

*Described in Engineering News, May 18, 1911, p. 601.

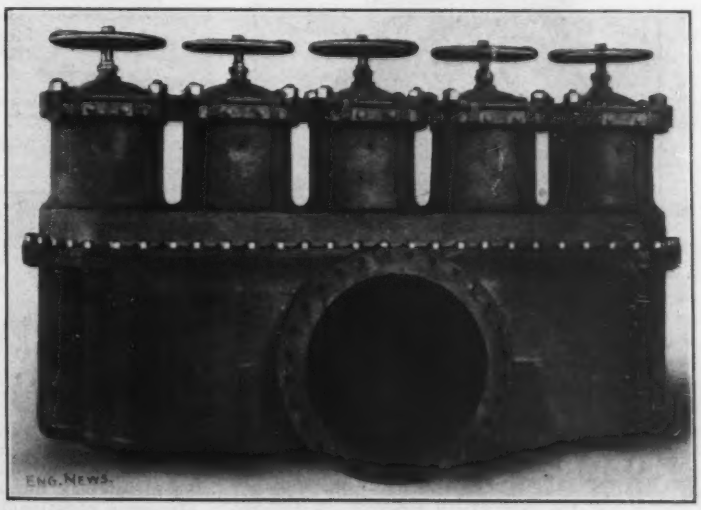
†See a description by Frank Richards in Eng. News, Dec. 2, 1909, p. 610.

A Large Strainer for Power-Plant Service.

The accompanying figure shows a type of strainer recently built for the Toledo Railway & Light Co. and for the Metropolitan Street Railway Co. of Kansas City. These are claimed to be the largest ever built for such service. Each one weighs 1,000 lbs., and measures 10 ft. 1½ ins. from end to end. The height above the bottom flange to the top of hand-wheel is 6 ft. 1 in. The strainers are to be inserted in the circulating systems of the condenser plants. The one in Toledo passes water from the Maumee River and the one in Kansas City from the Kaw Kaw River. The water in both cases is foul and liable to contain large suspended materials like sticks and leaves. It has been necessary, therefore, to make the strainers of very large proportions so that there will be little liability of their being put out of service. Each strainer is built with five independent baskets, three of these providing a greater free area than that of the 30-in. pipe in which the strainers are inserted. When all the baskets are in service, the straining area, is somewhat more than twice that of the supply pipe. It was believed that there would be little probability of having to remove two straining baskets at one time, but it was felt advisable to provide for such a contingency, in the case of trouble with floating ice in the spring.

In order to clean a basket, it is necessary first to turn the hand-wheel above the proper compartment. This raises the bucket entirely out of the strainer and at the same time shuts off the water from that compartment. The cover bolts may then be loosened, the cover removed and the basket lifted out. The foreign matter easily can be dumped and the basket quickly returned to its place.

In practice it is proposed to hold one basket out of service normally, as a reserve. It will then be kept raised in the upper half of the strainer body. When it is found desirable to clean the baskets, the spare basket can be quickly dropped into the strainer body with the turning of the hand-wheel and the other baskets removed one at a time. It is believed that this arrangement will provide insurance against a total clogging up of the strainer and a shut-off of the circulating water supply. These strainers were built by the Lagonda Manufacturing Co., of Springfield, Ohio, which has furnished us information from which the above article has been prepared.



A FIVE-SECTION STRAINER FOR CONDENSER CIRCULATING-WATER SYSTEMS.
(Built by the Lagonda Manufacturing Co., Springfield, Ohio.)

Gasoline Electric Cars on the Arad Hegyalja Ry. in Southern Hungary are being replaced by a 1,650-volt, direct-current overhead system, according to the "Electric Railway Journal" of Sept. 2. The total length of track is 36 miles, and the motor-cars will be of a double-truck type, with four 50-HP. motors each. The overhead line will be a catenary construction with counterweight tension adjustment. The construction is by the Ganz Co., of Budapest. The reason for the change is stated to lie in the increased traffic.

Ventilation of the Baltimore Tunnel of the Pennsylvania R. R. has recently been undertaken. The portion under change is 4,963 ft. long with a cross-sectional area of 432 sq. ft. The crown is 19 ft. above the rails and the total volume from end to end amounts to 2,150,000 cu. ft. Above one of the portals is located a fan room 30 × 36 ft., 16½ ft. high, the floor being 28 ft. above the tracks. In this room are two large fans of the "Sirocco" type, each measuring 18 × 14 ft. and 15½ ft. high. Both fans have outlets 5½ × 14 ft. discharging downward through the floor into a chamber surrounding the upper part of the tunnel. Air is discharged from this chamber through a long tapering nozzle carried around the entire perimeter of the tunnel above the tracks. To direct the flow of air forward, 450,000 cu. ft. per min. is to be supplied, producing a velocity through the tunnel of 1,040 ft. per min., or 12 mi. per hr., giving an air change each 4.75 mins. The reduction of tunnel cross-section space when a train is going through causes the air to travel faster than the train so that smoke is blown before the locomotive fast enough to give the engineer a clear view of the tracks. To discharge the required volume of air, one fan revolves at 104 r. p. m. requiring 190 HP. The second fan is intended as a spare unit. An old-style fan to do the same work would have been 30 ft. high at the casing and would have had a wheel diameter of 20 ft. compared with 12.5 ft. for the multi-blade type used. The older type would have required nearly twice the above power. This plant was designed by Mr. C. S. Churchill, Chief Engineer of the Norfolk & Western Ry., Roanoke, Va., designer of the ventilating system in the Galitzin tunnel of the Pennsylvania R. R., and those in the Big Bend and Elk Horn tunnels of the Norfolk & Western Ry. The machinery for the Baltimore tunnel plant was built by the American Blower Co., of Detroit.

A Portable Oil-Burning Reheater for Compressed Air.

One of the chief sources of loss of efficiency in the use of compressed air for driving shop tools and rock drills is in the cooling of the air after it leaves the compressor. During compression, the air is unavoidably heated and then it must cool again during its passage through the pipe line to the point where the tool is being operated. This cooling causes a decrease of volume which must be made up, in order to maintain the pressure, by compressing more air than would otherwise be required. Conversely, a considerable gain in power can be effected by reheating the air at a point near where it is to be used. Reheaters of the usual type burning coal or wood and somewhat resembling a hot-air furnace are not very generally used, however, except where a large amount of work is to be done at one point and where one large heater can supply a number of tools at once without being moved.

A portable heater with sufficient capacity to supply one drill has been recently put on the market which automatically maintains the desired temperature of the air passing through it.

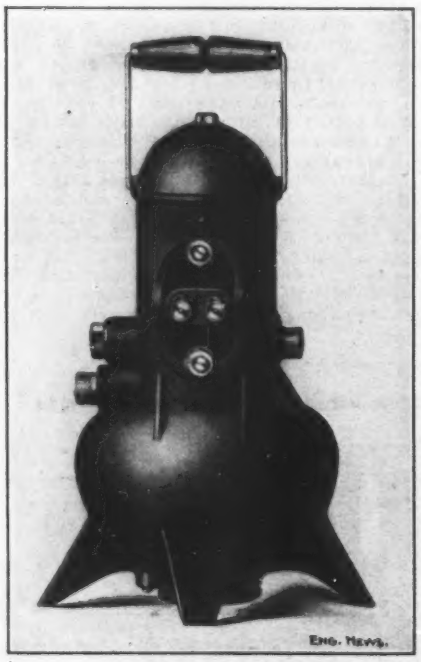


Fig. 1. Small Heater for 75 Cu. Ft. of Free Air Per Minute.

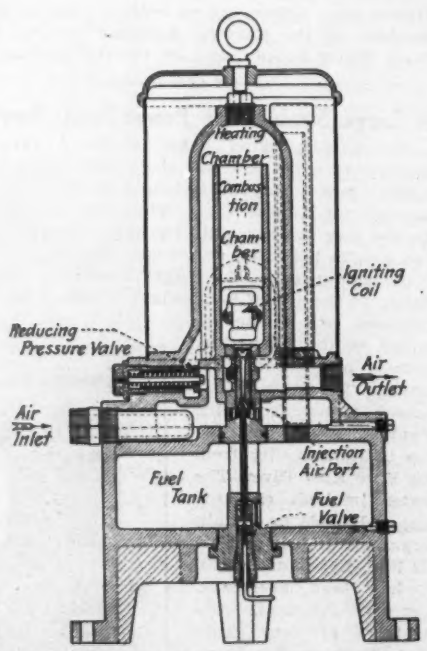


Fig. 2. Sectional View of Large Heater, Capacity 250 Cu. Ft. Per Minute.

FIGS. 1 AND 2. A PORTABLE OIL-BURNING REHEATER FOR COMPRESSED AIR.

This is accomplished by the combustion of gasoline or kerosene directly in the compressed air on its way through the heater. The fuel is injected into the combustion chamber by the current of air passing through, so that the heating is automatically kept up while the tool is in operation and discontinued when the tool is stopped. The mixture of fuel and air is ignited by an electric resistance coil or by a hot tube. The only attention required, it is claimed, is the initial adjustment of the fuel valve to give the desired temperature.

The general appearance and construction of the new heater are shown in the accompanying illustrations. Fig. 1 shows a small size weighing only about 40 lbs. and capable of supplying heated air at the rate of 75 cu. ft. of free air per min. This is about enough for a 2-in. or 2½-in. drill. Fig. 2 is a sectional view of a larger heater, having a maximum capacity of 250 cu. ft. of free air per min., enough for a 5½-in. drill. Its weight is about 150 lbs. The internal arrangement of both models is substantially the same. The supply line from the compressor is connected to the air inlet (Fig. 2) and the tool is connected with the outlet by a flexible steel hose. The metal hose is necessary instead of rubber to withstand the high temperature (350° F.) of the reheated air. The hose is insulated to reduce the loss by radiation.

The entering air fills an annular chamber just above the fuel tank at the base of the heater. From this space, most of the air passes into the heating chamber through the reducing-pressure valve set to maintain a pressure difference of a fraction of a pound. Due to this pressure difference, some of the entering air is by-passed up through the injection port, carrying with it oil from the tank below. A combustible mixture is formed and is lit by the igniting coil (or the hot tube) upon entering the combustion chamber above. The products of combustion mingle with the main body of air in the heating chamber and the heated air then passes from the outlet to the tool.

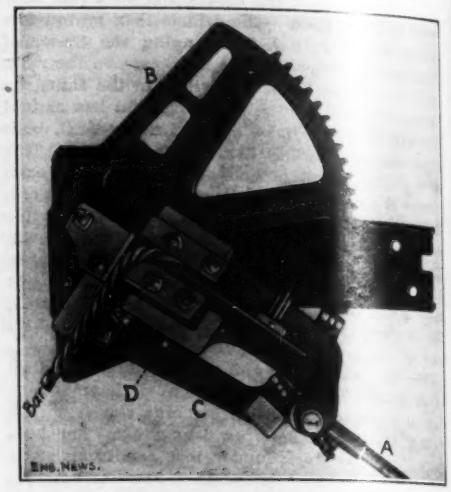
The heater is being put on the market by the maker, the Sterling Equipment Co., Peoples Gas Bldg., Chicago, Ill., under the trade name of the Sterling air economizer. It is claimed by the Sterling company that 100 cu. ft. of air per minute can be heated from 50° to 350° F. during ten hours of continuous running with about 2½ gals. of gasoline or kerosene.

Waterproofing Highway Bridge Floors in Berlin, Germany, was formerly done by making the pavement foundation of asphaltic concrete (on buckle-plates), but since 1897 has been done by placing a sheet-asphalt coat over a gravel concrete foundation (using no asphaltic concrete). This later construction, in which the stone or wood paving blocks were set on a sand or concrete bedding over the asphalt waterproofing, has given full satisfaction wherever the paving blocks were at least 4 ins. deep. Shallow stone-block pavements (3-in.) have been laid on both sheet-asphalt and asphalted-felt waterproofing in a bed of dry cement mortar, with good results in maintaining watertightness; thorough ramming of the stones to give an even surface seems to be essential for permanent solidity of the shallow pavement. (From notes by Gerhardt in "Zentralblatt der Bauverwaltung" of Sept. 2, 1911).

The Commission Plan of City Government was recently adopted at Omaha, Neb., by a vote of about 5,300 to 2,300, a large percentage of the voters refraining from casting their ballot. The commission plan was defeated at Orange, N. J., on Sept. 13, there being not only a majority of votes against the proposition but the total number of votes cast being below the required 60% of the number cast at the last general election.

A Machine for Bending Steel Rods for Concrete Reinforcement.

On very many jobs of reinforced concrete construction, some of the steel reinforcing bars have to be bent to shape on the ground and various manufactured machines for this work are on the market, while in several cases special devices have been improvised. The accompanying cut



A Machine for Making Angle Bends in Steel Bars For Reinforcing Concrete.
Wallace Supply Co., Chicago, Makers.

shows a plan of the working head of a machine of this sort, the head being mounted on a heavy cast-iron pedestal.

The ratchet handle (A) operates a pinion which gears with the segmental rack on the fixed frame (B), and the motion of the ratchet handle therefore causes the frame (C) to revolve upon the fixed frame. The gear ratio is about 12 to 1. The moving frame has dies to hold the end of the bar, and these can be adjusted by set screws (D) to fit the size of the bar. It is stated that the machine can bend cold bars of any form up to a thickness of 1¼ ins. The weight of the machine complete, including the pedestal, is about 500 lbs. This is one of several bending machines built by the Wallace Supply Co., of Chicago.

A Report on Street-Car Service in Providence, R. I., has been made to the City Council by Mr. B. J. Arnold, whose appointment for that purpose was noted in Engineering News of March 2. Among the recommendations made for improving conditions the following may be noted:

(1) Restoration of night cars to be run at intervals of not greater than an hour; (2) cross-town lines to connect sub-centers of business or residence to various parts of the system; (3) direct express service between the center of the city and suburbs; (4) electrification of steam railroad tracks from Union Station to suburban centers; (5) transfers between trolley lines and electrified steam roads under the same management; (6) increased car speeds through down-town districts, and increased speed of passenger movement at all points; (7) relocation of stopping points at an average of 500-ft. intervals outside of loading district; (8) complete rerouting of system to obviate schedule delays; (9) installation of electric switches at important intersections; (10) bestowing right of way upon street cars after fire, police and ambulance service with penalties on fractious teamsters; (11) discontinuance of trolley freight on main lines during rush hours and the development of a suitable freight terminal; (12) use of automatic semaphore signals on single-track lines; (13) use of a prepayment convertible car; (14) suction ventilation of cars; (15) use of front vestibule for exit; (16) adequate means of temporary rerouting in case of fire, etc.; (17) use of transparent illuminated signs exclusively in place of dashboard signs; (18) widening of several streets in the central section of the city; (19) better facilities for handling traffic to and from Roger Williams Park and baseball grounds, with terminal loops; (20) addition of 20 new cars per year to meet the normal growth of traffic, not including old equipment replaced.

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Loose Statements Regarding Sewage Disposal and Typhoid Fever.

Just what effect sewage disposal, properly or improperly conducted, has upon the public health is a question which needs careful immediate attention. There is altogether too much loose talking and writing on the subject, and unfortunately some of the loosest of it comes from the men who are generally supposed to know what's what in health-protective work. As an illustration, witness the following statement, which comprises nearly half of the editorial review of the month which appears in the September Bulletin of the Connecticut State Board of Health:

> Several bills were introduced at the beginning of the session designed to prevent the pollution of streams and tidal waters of the State. These, however, were all rejected on the unfavorable report of the Committee on Public Health and Safety. This is to be regretted as the proper disposal of sewage is the most urgent sanitary question in the State to-day. Two hundred and twenty-one cases of typhoid fever, which is undoubtedly less than the actual number, were reported during the month of August. How can we expect any improvement so long as our small streams and shallow harbors are filled with sewage beyond their capacity of proper disposal and the filth, containing very likely the typhoid germ, lies exposed on river banks and mud flats accessible to the typhoid-carrying fly?

The plain inference to be drawn from the foregoing comment is that adequate legislation for the control of water pollution is the first if not the only step necessary to eliminate typhoid from Connecticut. But how many of the 221 deaths were properly attributable to water pollution? Can the author of the statement make even an approximate distribution of them between polluted water, infected milk, direct contact with the sick and carrier infection, to say nothing of lesser modes of infection? And can he make the wildest guess as to how many of these 221 cases were due to "filth" from sewage "exposed on river banks and mud flats accessible to the typhoid-carrying fly"?

It is high time to stop these vague generalizations which place the responsibility for typhoid fever and other communicable diseases upon now one and now another cause and either to confess ignorance or else plead lack of appropriations for use in tracing cause and effect with some degree of scientific accuracy.

We suspect that one reason why the Committee on Public Health and Safety, mentioned in the quotation, reported unfavorably the bills to prevent water pollution was because no one with clear and convincing ideas on the subject stood sponsor for them.

It should be understood that we are not belittling the importance of state control of water-supply and sewage disposal. What we urge is that control should be founded on the latest scientific knowledge and practice. The people of our states and their representatives in our state legislatures are wofully ignorant of public-health matters. Such being the case it is not surprising that city and state health boards, selected by the people or by men elected to office by popular vote, should often prove to be mere blind leaders of the blind. But those who accept leadership have no excuse for not utilizing such light as is readily available to them.

A Rare Opportunity for City Planning.

Not since Washington and L'Enfant conferred together over the embryo city on the Potomac has there been such an opportunity for the exercise of the art of city planning as is now offered at the site fixed upon for the new federal capital of Australia. An international competition in planning this city is noted elsewhere in this issue. The three ideals always desired but rarely enjoyed in such work are there: A virgin country, ample funds and sympathetic supervision. These conditions are so different from those imposed in the reconstruction or the renovation of an old city that we can reasonably expect a workable as well as an artistic solution, a combination seldom achieved by city planners. Possibly we are of a Philistine nature, but the recent trend of large city re-planning, as illustrated by some of its most prominent exponents, seems to us to have departed so far from the practical as to remove their schemes from the fields of possible construction into the realms of decorative art. We have seen illustrations that merit a place on the walls of any art gallery, but which are no more likely to be carried out in actual construction than are the biblical plans of Solomon's temple. It is well to aim high, but above a certain elevation game is not very abundant.

Australia is a rich state and the deliberate and broad-minded manner in which it has set about the construction of its capital promise an absence of the restrictions that hedge about most city planning. We trust that those architects and engineers who are attracted by the fame and fortune attached to the design of that capital will not impose on the freedom allowed them, but will forget some of their art-school ideas and realize that though practical considerations may be sordid and unworthy of an artist, they ought not to be ignored in planning a home for a nation.

Encouraging Co-operative Ownership by Employees.

A great deal was heard a dozen years or so ago regarding profit-sharing methods as a means of promoting good relations between a manufacturing concern and its employees. Comparatively little attention seems to have been paid to this matter in recent years, but the need of some methods for promoting mutuality of interest between employers and employed is greater than ever.

The success of the United States Steel Corporation in encouraging ownership of its stock by employees of the company is pretty well known. A similar plan was recently worked out by the Union Switch & Signal Co., under direction of Col. H. G. Prout, Vice-President and General Manager. Some two months ago the company arranged to offer to its employees a thousand shares of common stock on easy terms of payment. Some 30 days was allowed for applications from the employees in accordance with the offer, and on Sept. 1, when the period for applications closed, it was found that 35% of the employees, including men in all grades of service from shop sweepers up, had made subscriptions amounting to 2,747 shares, or nearly three times the amount originally offered. The directors of the company were so favorably impressed with this evidence of interest on the part of the employees that they have arranged to allot the full amount of shares subscribed for.

Unit Stresses and Grading Rules in Structural Timber.

The exhaustive study into the properties and behavior of Douglas fir recently made by the U. S. Forest Service, an abstract of which appears on another page of this issue, makes a ready text from which to discourse on the difficulties of timber design and selection. While the particular investigation was made only on this one species of wood, the lessons to be drawn are generally applicable to all of the structural timbers, and the observations of Messrs. Cline and Knapp will bear reading in reference to the broad subject of wood as a structural material. Inasmuch as the pendulum now seems to be swinging back toward a more precise method of timber design, any experimental data regarding the strength qualities of the prominent woods is information of high value, and no work has done more to revise the old ideas regarding timber strengths than the series of experiments which have been carried on by the federal forestry engineers.

The first thing to be observed in the tests is the uniformly higher values that were obtained from the small, clearwood specimens. On account of the greater uniformity of these small test pieces and the absence of the usual structural defects in them, this increase in strength would be expected, but there are still in use by many designers safe unit stresses in timber, based on the high values obtained from small clear pieces of wood, resembling only in organic structure the heavy timbers for which the stresses are used. This condition is gradually being changed as the various societies that issue standards are coming to recognize the necessity for a large-size test piece as a basis for an ultimate strength standard.

The difficulty in establishing such a standard is well shown by the tests under consideration. Not only is it extremely difficult to establish grading rules under which the strongest woods may be recognized, but the variation in the strength of two pieces of wood apparently of the same composition and condition is both large and indeterminate. It is the practice in all structural material to test separate specimens in great numbers under the types of stress to which the material will be subjected in practice, from the results so obtained to establish an average ultimate limit of each stress and then to apply to that ultimate a factor of safety which gives a safe unit stress. Among the other unknown conditions which that factor is supposed to cover is the variation of the separate piece from the average. In the case of some materials of constant composition, this is of minor importance, but in wood, some of the latest experiments show that for some of the material which the engineer will have to use, the ordinary safety factor leaves but small margin for anything but this variation.

Take, for instance, the tests on compression parallel to the grain on the Douglas firs tested by the Forest Service, as shown in Fig. 1, on p. 381. According to the best gradings available, 75% of these test pieces would pass the inspection for any structural work, while the remaining 25% could be used on falsework and temporary structures. Yet in the large-size pieces, 6% were from 30 to 45% below the average, 9% were from 20 to 30% below, 14% from 10 to 20% below and 10% from 5 to 10% below. The lowest of these are probably in the "seconds" class and would not pass merchantable inspection, but not all by any means, as the figures in Table IV., on p. 382 show. It is evident from this table that, using

the extreme fiber stress in bending as a criterion, the variation of both the first and second classes of timber, hardly distinguishable from each other according to the bulletin, is very great. The 10% of the total pieces tested which showed the lowest strength values averaged 26% below the general average of all the pieces tested. That is, the safety factor in the weaker pieces is only three-quarters of that assumed for the average.

To illustrate how this affects unit values, take the unit stress value for extreme fiber bending in Douglas fir, as given in the latest specification of the American Railway Engineering Association. The value there given is 6,100 lbs. per sq. in., ultimate and 1,200 lbs. per sq. in. safe, a safety factor of about 5 on a remarkably high assumption. Now according to Table IV, there were, for instance, 8 sticks out of the 75 merchantable ones tested by the Forest Service whose ultimate extreme fiber stress in bending dropped as low as 2,580 lbs. per sq. in. Any structure which had contained these pieces would, then, have had a factor of safety of 2 only, if the prescribed unit value had been used. Some of the seconds or culls, which conceivably might be classed as "Douglas fir" and hence designed under a safe unit value of 1,200 lbs., drop below 2,000 lbs. in ultimate strength. Needless to say, the factors are insufficient to cover the various factors of ignorance and emergency for which this safe value is intended to provide. There are other safe unit stresses prescribed by various authorities which are lower than the one noted, but that is the official announcement of an authoritative body and is doubtless used by many engineers who regard Douglas fir as Douglas fir, so long as it passes a more or less rigid specification. There will always be this tendency to forget that the average rarely occurs, and that with a large variation from it the average is of little but a mathematical interest.

It might be expected that this deviation from the average could be cared for by a proper grading specification, but the bulletin in question shows that this has not been possible, nor does it seem to be possible. If certain rules could be devised whereby by ocular examination the low limits of strength in any piece could be determined, there would be no danger of getting timber that tested 30% below the average of its class. Then the inspector could be sure that he had selected all of the desirable timber out of that offered and also that those pieces that he had selected were of the proper strength. As it is, most of the specifications are almost useless in sorting the good timber pieces from the bad, and the two that are of any value do not ensure an absolutely correct selection. While they do seem fairly effective in placing only strong timber in the prime class, they do not get all of the available material there is. It is, perhaps, too much to expect that the ideal grading rule can be devised for an organic material, subject to all the eccentricities of organic growth, but that very fact makes it all the more imperative that conservative unit values be used for such timbers as are expected to carry any important load for a long time. There seems to be no certainty that one of the passable pieces may not drop in strength dangerously near its designed value.

At Last a Practical Compound Rail.

One of the tasks over which inventors have struggled for half a century without success is the production of a compound rail, or a railway rail having the base separate from the head, so that the head can be renewed when worn without scrapping the base or even taking it up.

A great number of patents have been taken out on compound rails; but not one has ever achieved commercial success. The reasons for the failure are evident to an engineer. The late A. M. Wellington thirty years ago emphasized the importance of stiffness in a rail section; and that quality is vastly more important with the wheel loads and the train speeds common in railway practice to-day.

Nearly all the designers of compound rails have been ignorant of this fundamental requirement; and they have introduced a horizontal joint in the web of the rail, between the base section and the top section with no understanding of the fatal effect on stiffness and durability.

We illustrate in this issue, however, a compound rail which has been actually put into service in Europe and with such satisfactory results that a considerable length of it is to be laid on the Chicago street railways. The merit of this design will be evident almost at a glance. The base section is itself a substantial T-rail with a fair sized head, and the head section is simply a cap which is secured to the head of the base section by cold bending of flanges, somewhat as the lock-bar in a Ferguson pipe joint is closed down.

There are many questions which will occur to the engineer who critically examines this rail, as for example whether the head can be made of sufficiently hard steel and still have the flanges soft enough to close down upon the lower section without cracking. It may also be questioned whether a sag will not form in the head where it comes over the joint in the base. It may be necessary to add angle-bars here to maintain the stiffness of the rail across the joint.

It will, of course, be understood that the rail is intended for low-speed traffic on city streets and not for main line use. The difficulties and expense in maintaining rails and rail joints, mechanical and electrical, on street railways of heavy traffic are such that any scheme which promises to reduce these difficulties is deserving of a thorough trial.

Damming the Mississippi River to Develop Water-Power.

One of the boldest enterprises in the field of hydraulic power ever undertaken in the United States is described in this issue. A dam is being constructed across the Mississippi River at Keokuk, Ia., which will drown the Keokuk Rapids and create a still water pool extending up the river for some 60 miles.

It is well to point out that this engineering feat is made possible by the fact that the upper Mississippi River, (by which is meant that portion of the river above the junction of the Missouri), is very different in character from the lower Mississippi, which flows through a deep alluvial formation with rock available for foundations only at great depth.

The Upper Mississippi, moreover, is a much more regular stream and less subject to sudden torrential floods than the two great rivers which contribute a large part of the volume of the lower Mississippi, the Ohio, coming in from the east, and the Missouri, from the West.

The upper Mississippi river derives most of its waters from Minnesota and Wisconsin, and the great number of lakes upon its watershed conduces to regularity of flow. The maximum variation, according to observations for over twenty years, is only 1 to 18, the minimum flow at Keokuk being about 20,000 cu. ft. per sec., and the maximum a little over 370,000. It will be apparent that to take care of the flood waters of a stream with the latter volume is no mean engineering problem.

The foundation conditions at Keokuk are particularly favorable. The Rapids are formed by the flow of the river over nearly level beds of solid limestone, and neither the depth nor the velocity of the flow are sufficiently great to offer serious difficulties to cofferdam construction for laying dry sections of the river bed. If, however, it were attempted to build a dam across the river according to ordinary methods, by which the complete structure is carried across until closure is finally effected at the center, the problem of carrying the normal flow of the river while the last sections of the dam are being constructed would be an extremely difficult one, to say the least.

Mr. Hugh Cooper, the Chief Engineer of the project, to whose perseverance, energy and engineering ability the entire enterprise is due, has adopted at Keokuk the same method of dam construction which he successfully carried out in building the McCall Ferry power plant on the Susquehanna River. At McCall Ferry the dam was built up with dam sections and openings alternating. Not until a row of these dam sections was completed across the river was the work of closing the intervals between them begun. It was then a matter of comparative ease to close off from the water a section between two piers and lay it dry ready for the placing of concrete.

At Keokuk a somewhat similar plan is being followed, varied, however, to suit the special conditions. A concrete bridge is first being carried across the river, having piers 6 ft. in thickness, spaced 30 ft. apart, surmounted by concrete arches located well above high water on the completed dam. After this bridge is carried across the river, successive sections between the piers are closed off and pumped out and the dam section is then built up in this 30-ft. space. In building the piers, provision is made for the placing of cofferdam protection, with the piers as a support, when the final closure is undertaken.

One of the difficulties in economic development of power at Keokuk is the comparatively small head available. If an ordinary overfall dam were carried across the river, its crest would have to be placed at such a low elevation, in order not to give too great a height to floods back of the dam, that only a low head would be available during the low-water season. Of course, ordinary flash boards might be placed to help out the low water height to some extent, but the limitations to the use of either ordinary or automatic flash boards on an overfall dam are pretty well known. The ice conditions during the winter months would be apt to give more or less trouble with any such scheme.

By placing a substantial bridge over this dam, however, Mr. Cooper has been enabled to make a very substantial variation between high and low-water level on the crest. In place of flash boards, he is able to use substantial steel gates, by which, during low water, the height of the dam crest may be increased as much as eleven feet. At high water these gates are lowered, giving a large area between the arch of the bridge and the masonry crest of the dam for the passage of flood waters. By this means, the head on the turbines is raised to as much as 39 ft. at low water, when the supply must be economized as much as possible. At high water, on the other hand, when an abundance of water is available, the head may be reduced to as little as 21 ft.

One of the most interesting features in the construction of the work is the use which is being made of travelers for handling both the concrete and the steel forms used in the dam construction. The great gain in economy, both in cost and in time of erection, which the traveler has brought about in the work of bridge erection is well known; but, so far as we recall, this is the first case where a traveler has been applied to the work of dam construction. It will be apparent, of course, that this application is made possible by the fact that the structure is a bridge as well as a dam, and by the particular method of operation by which the dam is being constructed. We have no doubt, however, that the economy in both money and time due to this use of the traveler is more than sufficient to pay for the cost of the arches and piers which constitute the bridge above the dam, even if the bridge were not a valuable adjunct to the dam anyway.

We have little doubt that this application of the bridge traveler to dam construction is responsible more than anything else for the extremely rapid progress which is being attained in construction. Notwithstanding the magnitude of the work and the enormous amount of plant employed in construction—aggregating about $1,000,000 in value—it is expected to have the plant ready to develop electric power by July 1, 1913.

The Present Outlook for Industrial Trusts.

President Taft's address at Detroit last week stating the attitude which his administration may be expected to take toward the Trusts is of great interest to the business world. Briefly summarized, President Taft holds that the Sherman law has been upheld by the Supreme Court decisions in the Standard Oil and Tobacco cases and that it is to be enforced, therefore, until free competition is actually reestablished in the industrial world. The following brief quotation presents the President's position in a nutshell:

> It needed these two great decisions to teach the business public that at least not in the supreme tribunal of this country would the claim be listened to that in this day and generation we have passed beyond the possibility of free competition as consistent with proper business growth, or that we have reached a time when only regulated monopoly and the fixing of prices by governmental authority are consistent with future progress.
>
> We did get along with competition; we can get along with it. We did get along without monopoly; we can get along without it; and the business men of this country must square themselves to that necessity. Either that, or we must proceed to State socialism and vest the government with power to run every business.

This is not only a declaration that further making of trusts must stop. It is a declaration that the trusts now doing business which have any kind of monopolistic control over an industry must be reorganized.

That this declaration is appreciated at its full significance in the business world is indicated by the published statement that the International Harvester Co. is planning to reestablish the independent organizations by whose consolidation it was created and that it is taking this step as an alternative to Federal prosecution. Current rumors indicate that other great combinations are likewise diligently at work upon plans for reorganization which may place them within the pale of the law.

The difficulties of undoing consolidation and reestablishing competition so as to carry out the spirit as well as the letter of the law are exceedingly great. In many of the combinations the old organizations out of which the "trust" was formed have been entirely wiped out. Even where the skeletons of these former organizations remain, merely reanimating them will not re-create competition if the same set of men is put in control of all these different sub-companies. It really makes no difference to the public what the inter-company organization may be of a trust's component parts, if these different parts fail to compete with each other. And no law was ever made which could compel two men or two firms or two companies to compete with each other if they did not want to compete.

On the other hand, the law can and without doubt will put very serious obstacles in the way of all schemes for *preventing* competition. All business done on a large scale nowadays is done by corporations; and since corporations are creatures of the law anyway, they may not safely transgress it. Thus while the law is powerless to compel competition it has plenty of power to prevent the adoption of business methods which restrict competition.

It is well that the situation has been so clearly and tersely stated by the President. There are as he says only two alternatives. Either our industries must be maintained on a competitive basis, so that the consumer can secure the necessities of life at a reasonable cost; or else Government must step in and control these various lines of business.

The so-called "public utilities"—the means for public transportation and communication—are now well understood to be natural monopolies anyway, and after much costly experience the attempt to keep alive competition in this field has been everywhere abandoned and either public ownership or public regulation is being adopted the world over.

But in the great producing industries, as the President says, we did have competition in the past, and with the enforcement of the law we may have it again. Certainly it is better to make some attempt at least to reestablish it, than it is to establish Government control over every one of our trust-controlled industries from steel to chewing gum.

Moreover, the experience of a score of years has shown that many of the big trusts are too big for efficient operation. With all the admitted advantages which they possess, there are not a few disadvantages which handicap them in the race with the small producer. Of course if they are permitted to take advantage of their mere size, they can crush him; but public opinion and the law ought to protect the small producer against competition of this sort. The business world already recognizes that it is foul play for a big concern to wipe out a small competitor by quoting prices below cost in the field in which he operates. If the law would protect the independent producer against such unfair competition, there are many of the trusts which would have as hard a time defending themselves against their smaller competitors as Gulliver did when beset by the Lilliputians.

In previous years when the power of the law has been invoked to limit the growth of trust monopolies, those who are most insistent against Governmental interference with what they are pleased to call private business have looked to this or that or the other political faction to espouse their cause. This year, however, they look in vain. If the next presidency falls to the party now in power, it will be either President Taft himself or some one of far more radical views. Of the chief candidates prominent in the opposing party, the one who has been most generally regarded as representing conservative non-interference with business interests has just been named to support the authority of States to order reductions in railway rates regardless of the Federal Courts.

No one wonders that under these circumstances the lawyers who earned fat fees a few years ago by advising the trust promoters how to do what they desired by getting around the law are now working overtime to find how these clients can so mend their ways as to obey the law.

LETTERS TO THE EDITOR.

A Formula for Determining the Position of Mallet Locomotive Coupling Pins.

Sir: The question has often been asked whether the position of the coupling pin between Mallet locomotive units is determined by the degree of curvature of the track, or whether, if the position of the pin be correctly located for any given curve, it will be correctly located for any other

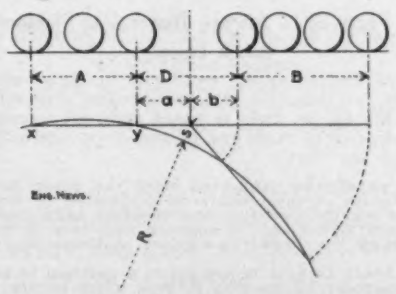


Diagram for Derivation of Mallet Locomotive Coupling-Pin Formula.

curve which the rigid wheel-bases and the permissible swing of the front unit would allow.

The following simple mathematical demonstration will serve to prove that the location of this pin is independent of the degree of curvature, and is dependent entirely upon the rigid wheel-bases of the respective units and the distance between them.

Considering first the case where the rigid wheel-bases are not equal to each other; in the figure herewith, let

A = rigid wheel-base of front unit.
B = rigid wheel-base of back unit.
D = intervening space between the two rigid wheel-bases.
a and b = the distances from the coupling pin to the respective rigid wheel-bases.

All dimensions to be expressed in terms of the same denomination.

It is evident that

$$a\,(A + a) = (2R + S)S \quad \ldots\ldots(1)^*$$
$$b\,(B + b) = (2R + S)S \quad \ldots\ldots(2)$$

From equation (1) we see that the expression $a\,(A + a)$, which is made up of constant quantities, will satisfy the equation for innumerable values of the variable quantities in the expression $(2R + S)S$, for it is perfectly obvious that there are innumerable circles which will pass through the points x and y, for each of which circles equation (1) is true. The same is also true of equation (2). Now, since the value of the expression $(2R + S)S$ is constant for all circles passing through the points x and y, we have

$$a\,(A + a) = b\,(B + b) = (2R + S)S$$

then substituting $(D - a)$ for b

$$a\,(A + a) = (D - a)\,[B + (D - a)]$$
$$aA + a^2 = DB - aB + D^2 - 2aD + a^2$$
$$a\,(A + B + 2D) = D\,(B + D)$$
$$a = \frac{D\,(B + D}{A + B + 2D)} \quad \ldots\ldots(3)$$

or substituting $(D - b)$ for a

$$b = \frac{D\,(A + D}{A + B + 2D)} \quad \ldots\ldots(4)$$

It is obvious, in the case where the rigid wheel-bases are equal to each other, that the pin will be midway between the two units and a and b will each be equal to $\frac{D}{2}$.

The theoretical position for the coupling pin as determined by equation (3) or (4) is not always obsedved in actual practice, owing to opposing difficulties in the way of design; but inasmuch as Mallet locomotives are not expected to take very sharp curves, a few inches deviation from the theoretical position will not cause any ill results.

If, however, a Mallet locomotive were being designed to take a very sharp curve, the coupling pin should be placed as near as possible to its theoretically correct position, otherwise the result might be either the derailing of the locomotive or the spreading of the rails in rounding the curve.

H. C. Weaver.

The Baldwin Locomotive Works, Philadelphia, Pa., September 7, 1911.

Development of the Suction Conveyor.

Sir: I notice in reading the interesting article in your issue of August 31, entitled "Recent Developments of the Suction Conveyors," that no mention is made of the power used to operate the exhausters, which is a question that naturally suggests itself. I have in mind three of these installations in plants of moderate size, one of which is operated by a 45-HP. motor, another (recently abandoned) required a 75-HP. motor, and a third is operated by a motor of 100 HP.

Very truly yours,

Staunton B. Peck.

Link-Belt Co., Chicago, Ill., Sept. 2, 1911.

[The author of the article has made the following reply.—Ed.]

Sir: Answering the inquiry by Mr. Peck, as to the power consumption in suction conveyor work, I would say that in a power plant of moderate size, a 6 or 8-in. duct with a 20-HP. exhauster set is the usual requirement. For power plants of larger size, say about 5,000 HP, we usually install a 30-HP. set. The suction pressure and therefore the power required of course depends on the length of haul and the number of changes in direction in the conveyor duct. With a 30-HP. set, the maximum for satisfactory performance is usually about a 300-ft. length of haul.

It is seldom necessary to go above 50 HP. unless the length of haul is unusual, or the capacity desired is large. The power consumption of the suction conveyor is higher than for a mechanical conveyor, while the cost of maintenance and repairs is considerably less. This is particularly so in the case of handling ashes or other corrosive and abrasive materials. I have found that engineers are not particularly interested in the question of how much power it takes to operate conveying machinery, but that they are very much interested in cleanliness of operation and freedom from breakdowns. The disablement of the coal or ashes handling system at the average power house is often disastrous beyond all question of the power costs.

For handling ashes, about the only other form of conveyor suited to the usual conditions in

*The derivation of this equation from the similarity of triangles will be made clear by completing the circle of radius R and connecting the point s with the further end of the diameter passing through the pin.—Ed.

large power plants is the pivoted-bucket carrier. This is peculiarly economical in power consumption. The only comparative data I have is in the case of a power plant of about 16,000-HP. capacity. One-half of the output of ashes is handled in a pivoted-bucket carrier and the other half by a 10-in. Darley suction conveyor. Each is operated with an expenditure of 50 HP., the carrier having a conveying capacity of approximately 30 tons per hour and the suction conveyor of 20 tons per hour. The advantage claimed for the latter in this service being the decreased maintenance costs and the automatic quenching.

I trust that this gives the information desired.

Yours very truly,

W. G. Hudson.

Guarantee Construction Co., 140 Cedar St., New York City.

Two Suggested Safety Devices for Railway Use.

Sir: The writer begs to suggest two very simple and comparatively cheap attachments to the steam locomotive, which would considerably aid the locomotive engineer running a train at night, which is the time when most accidents occur.

1.—The equipment of all locomotives with a **safety throttle,** arranged in the same way as the controller levers on the electric trains in both the New York and Boston Subways. These controller levers require the pressure of the driver's hand at all times. The moment this pressure of the hand is removed for any reason whatever, illness of the engineer, or temporary fainting spell, or accident, the throttle is at once automatically closed, and at the same time the air brakes are applied.

This is an automatic attachment, which has worked perfectly for several years on the subway trains. There would seem to be no reason why a locomotive could not be equipped with such an attachment, and if so every state in the country should require this.

2.—**Locomotive head-lights** should be equipped with acetylene or electric searchlights, such as the electric suburban cars now use. This would almost entirely prevent accidents where obstructions are placed on the track at night as the light would enable the engineer to easily detect them at a considerable distance. It would also serve as an additional safeguard against grade crossing disasters, as the light can be seen from a long distance by those approaching a crossing.

The situation to-day as regards the actual driving of a locomotive, is that during the night the locomotive engineer **trusts absolutely in Providence that his rail is clear.** The only help he has is from the block signals, and even these are only found on the Eastern railways.

The above two suggested devices are simple, would not be expensive, and would certainly make for greater safety to travellers.

Very sincerely yours,

Louis T. Buff.

Jamaica Plain, Boston, Mass., Sept. 11, 1911.

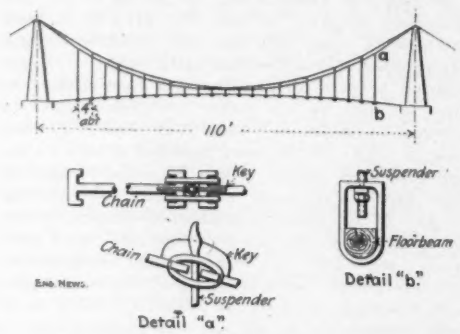
[It would not be a difficult matter to design a throttle-valve operating device for a steam locomotive which would meet the conditions laid down by our correspondent. As to its value as a safety device, there is room for difference of opinion. Accident to a train because of sudden incapacity of the engineer is of very infrequent occurrence. If there were any possible chance for the mechanism of the throttle operating device to become deranged, it might cause a serious accident by leaving the engineer helpless to control his throttle at a critical moment. Again under present conditions a locomotive runner has to move around in the cab more or less. He has to have both hands and sometimes the help of the fireman to throw over the reverse lever on heavy locomotives. Steam-operated reverse-levers would have to accompany automatic throttles.

Further, there is not the same reason for equipping the ordinary steam locomotive with automatic throttle that exists in the case of subway trains. On the subway train there is no one to discover any sudden illness or incapacity of the motorman and take his place. On a steam locomotive the fireman is at hand to relieve the engine runner in case of emergency.

As for the high-powered headlights, it is a much controverted question whether their advantages outweigh their disadvantages. That they confuse the color of signal lights appears to be well established. Perhaps a good solution would be for a locomotive to have like the electric cars two headlights, one of high-power for the open road and another of moderate power to use when the high-power light was turned off in approaching block-signals or passing through yards.—Ed.]

An Early German Double-Chain Suspension Bridge.

Sir: In your issue of Aug. 3, 1911, you gave an interesting description of the old chain bridge at Newburyport, Mass. Perhaps your readers will be interested by the enclosed sketch of an old chain bridge in a quaint old corner of Nuremberg, Germany. The bridge was built in the early twenties of the last century. It is directly inside of the old city wall, crossing the river Pegnitz. It consists of two openings of about 110-ft. span each. The bridge floor consists of wooden cross-girders and longitudinal planking; it is about 8 ft. wide, if I remember correctly. The pillars are



Old Double-Chain Suspension Bridge Over the Pegnitz at Nuremberg, Germany.

some 20 ft. high and apparently of wood. They carry two chains, from which the suspenders are hung alternately. The most interesting feature seems to me the connection of chains and suspenders. As can be seen from the sketch the chains are made of rounds, about 1½ ins. diameter, which are forged at the ends to form a Γ. Two consecutive chain-bars are connected by two chain-links in the manner shown, and the suspender is hung from the joint by a key, which passes through the upset end of the rod. The lower end of the suspender is threaded, and the floor is carried by a stirrup fastened to the suspenders by a nut and washer.

K. A. Müllenhoff.

Sterkrade, Rhineland, Germany, Aug. 30, 1911.

The Facts as to Sewage Disposal at Plankinton, South Dakota.

Sir: The editorial comment in Engineering News for Aug. 31, 1911, on sewage disposal at Plankinton, So. Dak. is based upon an erroneous assumption of facts and is, therefore, misleading.

You say that

two physicians connected with the State Board of Health recently made an inspection to determine whether or not the (septic) tank was a menace to health. It appears that this particular tank has been the subject of litigation, etc.

If South Dakota is not yet in a position to have an engineer of its own to look after purely engineering matters, we dare say that Minnesota would be neighborly enough to loan it an engineer for special investigations like the Plankinton case.

It is surprising that Engineering News, usually so careful in its statements, would publish an article that is not only inaccurate, but which contains an uncalled for fling against the engineering department of this state.

The facts are these: The town of Plankinton has a sewer, constructed of vitrified sewer pipe, 18 ins. in diameter; this sewer discharges into a ravine near the outskirts of the town. A farmer, residing in the vicinity of the sewer outlet, obtained an injunction against the use of the sewer by the city under existing conditions. The matter was referred to the State Board of Health and two members of the Board visited the locality to satisfy themselves concerning local conditions. Later on, the Board of Health requested the State Engineer to make an examination and report, with recommendations, concerning sanitary conditions at Plankinton, and this was accordingly done. For your information a copy of this report is enclosed herewith.

South Dakota is fully able to have an engineer of its own and does not need to borrow engineering talent from neighboring states.

Yours very truly,

Samuel H. L[illegible]

State Engineer.

Pierre, S. D., Sept.4, 1911.

[We greatly regret that we were misled as to the facts in the Plankinton case, and especially that our comment was so worded as to seem to reflect on any State department or official of South Dakota other than the State Board of Health. We are gratified to learn that the Board did finally call upon the State Engineer for advice.

Describing an open pool of sewage as a septic tank, as appears to have been done in the reports that first reached us from Plankinton, illustrates the vague ideas regarding sanitary matters which one too often finds spread abroad in the public press.—Ed.]

The Organization of Local Associations in the American Society of Civil Engineers.

Sir: In the editorial published in your issue of Aug. 3, 1911, under the title "Changes in the Organization of the National Engineering Societies," the following statement is made:

Even in the American Society of Civil Engineers, while the governing body of the Society has looked with no favor on any project for local branches of the Society, the members resident in San Francisco and in Washington, exercising their rights as free-born American citizens, have in each city formed an organization of their own, which holds regular meetings and is carried on very successfully and profitably.

I do not know the source of the information on which this statement is based, but it appears to me proper that your attention should be called to the fact that there is no truth in it, and that you should be requested, in justice to the American Society of Civil Engineers, to publish this letter.

It is true that there is an organization with headquarters at San Francisco known as the "San Francisco Association of Members of the American Society of Civil Engineers," and I might add that there is also an organization known as the "Colorado Association of Members of the American Society of Civil Engineers," with headquarters at Denver. The former dates from April, 1905, and the latter from December, 1908.

Similar organizations have been formed in Kansas City, Mo., and in Washington, D. C., but these have never been active.

The project for the organization of these associations of members originated with the undersigned, and he brought it to the attention of the Board of Direction of the Society, and after the general project had received its sanction, took up the matter with prominent members of the Society in all of the centers of population in the United States; that is to say, wherever there was a sufficient number of members to warrant the hope that such an association would be successful.

Both the San Francisco and Colorado Associations, which have been carried on "successfully and profitably," both to their local membership and to the Society as a whole, originated in this manner; the Constitutions under which they have prospered were prepared in this office, and before their adoption were approved by the Board of Direction of the American Society of Civil Engineers.

Moreover the minutes of the meetings of these Associations are regularly published in the monthly "Proceedings" of this Society, and its technical publications contain a number of papers and many discussions which originated in the meetings of these associations.

Permit me to repeat what I have said several times in the past, that should the Engineering News at any time desire correct information concerning this Society on which to base news items or editorial comment, I will, upon request, be only too happy to give it promptly.

Apart from the matter above discussed I beg leave to say that I have read your editorial with great interest, and that your general view that "the broadening of the National Engineering Societies by the organization of local associations of members is one essential to the greatest usefulness of all these Societies" have my hearty concurrence. That statement in your editorial and many of the arguments which follow in its support are almost identical with those I have

used during the past eight years whenever this subject has been discussed in this Society.

Yours respectfully,
Charles Warren Hunt, Secretary.

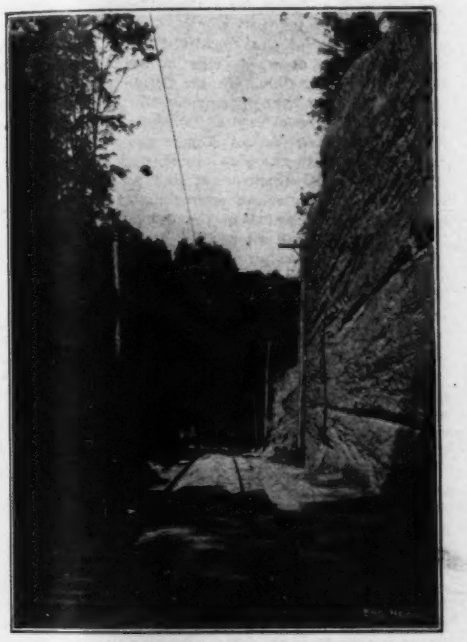
220 West 57th St., New York, Sept. 18, 1911.

[We give space with pleasure to the above correction and regret that we were under a misapprehension as to the attitude of the Board of Direction of the American Society of Civil Engineers toward the organization of local branches of the Society at principal centers throughout the country. With the hearty cooperation and support of the Society's officers assured, it seems to us that the successful organizations at Denver and San Francisco might well be copied in other cities.—Ed.]

A Vertical Railway Cut Through Loess Earth.

Sir: The accompanying half-tone shows a view in a cut on the line of the Helena Interurban Ry., an electric road, about 1½ miles from Helena, Ark. All the cuts on this section of the line are similar to this, through a loess earth formation absolutely devoid of rock. As in the view, all of the cuts are absolutely vertical. This particular one is 50 ft. deep and just wide enough for the safe passage of the car. The road has been in operation about 15 months.

The loess earth is a sandy, calcareous, fine-grained clay, and is widely distributed through



A 50-Ft. Vertical Cut Through Loess Earth.

this section of the country. Originally the theory was that it was a dust deposit but it is now generally believed that it is of an alluvial nature. It has been the habit of the engineers to make all cuts through it with vertical sides, and as a rule these walls have held, but in the cut shown in the view, the jarring action of a passing car loosened the surface, about two months ago, and brought down a slide across the track immediately after the car had passed. This slide occurred on the left side of the cut shown, and filled the cut to a depth of 8 ft.

J. A. Guissinger.

Helena, Ark., Aug. 27, 1911.

The Folly of Paying for Short-Lived Road Surfacing and Street Pavements with Long-Term Bonds.

Sir: I have read with interest the editorial note in your issue of to-day, on "Good Roads Problems and Fallacies," especially that portion in italics. I gave this matter consideration in a paper which I read some time ago before the National Good Roads Congress at Birmingham, Ala. (see "Engineering Record," May 27, 1911). I enclose a copy of the paper, and would particularly refer you to the remarks which are blue penciled on the margin.

I am very glad that you have taken the question up in your columns, as it cannot be too thoroughly ventilated. The selling of long-term bonds for the construction of "good roads" and city pavements, cannot be shown up too promptly or too strongly.

Clifford Richardson.

30 Church St., New York, Sept. 21, 1911.

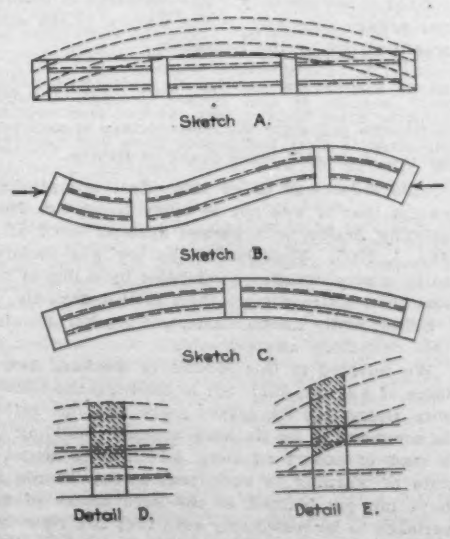
[The paper which our correspondent mentions was entitled "The Road Problem in the Light of Our Present Information." It dealt chiefly with the cost and life of broken-stone roads, and emphasized the short life of water-bound macadam and the lack of knowledge as to the life of bituminous-bound macadam. The paper concluded as follows:

The final point to be considered in solving the problem of road construction is an appreciation of the fact that the mere appropriation of a large amount of money for the purpose does not end the matter. Nothing will last forever. All roads will wear out, and provision must be made for their replacement. One appropriation merely means that another will be required after a limited number of years, together with the cost of maintenance in the meantime. There has, as yet, been little or no realization of this fact in connection with country roads. As an example, I may cite the fact that the asphalt pavements in the Borough of Manhattan, in New York, have been seriously criticised during the past winter because of their very bad condition. The public does not realize that a third of these pavements are from 15 to 22 years old and should have been replaced some years ago. They are at the end of their life. No provision has been made for a fund to carry on this work. The original surfaces were paid for by the sale of corporate stock or bonds, which have not yet matured. The city, therefore, is still in debt for its worn-out streets, and finds it a problem as to how to replace them. There seems to be no realization of the fact that the construction of pavements and roads is, as Mr. Whinery stated in his book, "a purely commercial and engineering problem—the design of means to meet certain ends—and the whole treatment of the problem should be based on business considerations." This is certainly not the way the problem is being looked at to-day. The entire disregard and misunderstanding of the problem of the depreciation of roads and pavements with age, and of their replacement and provisions therefor, is hardly considered in a rational way in America to-day. It is one of the most important elements in the solution of the road problem. For a realization of the situation I cannot do better than refer all highway engineers to its exposition by Mr. Whinery.

The book referred to is "Municipal Public Works," by Mr. Samuel Whinery (New York: 1903).—Ed.]

The Hamburg Gas-Holder Failure and the Strength of Tie-Plated Columns.

Sir: Judging from the sketch given in your issue of July 27, Mr. Edward Godfrey does not seem to have comprehended the reasons why tie-plates ever have been in use.



Sketches Illustrating the Behavior of Tie-Plated Columns.

The column "A" sketched by Mr. Godfrey, under endwise compression, never will bow as shown by him. Unless one of the channels buckles between tie-plates, the column as a whole will bend as shown in Sketch B, as has been proven by numerous tests. Only if there is a tie-plate in the center of the column, will it buckle in a single bow, Sketch C. The reason is very simple: In Sketch C and detail D the center tie-plate only moves sideward. There is no strain in it, as the shear of a uniformly loaded beam equals zero in the middle. But in Sketch B and detail E evidently there is strain, for if the column bends, a yielding tie-plate would form a parallelogram. Now as a steel tie-plate is rigid and remains rectangular, it takes up strains, hence it is a means to prevent buckling of a column.

This is not a bit of "mathematical rot," it is only a common-sense consideration.

Undoubtedly latticing is better than tie-plating, but a column or strut with sufficient tie-plates, well designed, in most cases is as good as a column with "that-will-do"-flat-tie-bar-latticing.

E. T. Ziegler.

Sterkrade, Rheinland, Germany, Aug. 15, 1911

Sir: I have before me copy of a letter from Mr. E. T. Ziegler, of Sterkrade, criticising my stricture on the tie-plated column, in a letter in your issue of July 27, in which the failure of a gas-holder was referred to, and thank you for the opportunity to reply.

Mr. Ziegler refers to numerous tests on tie-plated columns. A record of these tests would be valuable. They seem to be hard to find. It is possible that good substantial tie plates, with three or more rivets in a row, would cause a column to take a double curve as in his Sketch B. But two-rivet plateb, of a size that can be carried in a coat pocket, can scarcely add any rigidity to a column carrying more than 100,000 lbs., except in the immediate vicinity of the plate. Of course on a blackboard in a school room, or in a greatly exaggerated figure, the tie plate would not allow the column to take the shape shown in Sketch A, as it would distort the parallelogram. The same might be argued if only one rivet connected the tie plate and channel, since friction would prevent rotation. This line of argument would have more force if the tie plates were one piece with the channel or perfectly attached thereto. But rivets are subject to slip, sometimes under small stress, and an exceedingly minute slip would allow all of the motion necessary for the column to assume the dotted position of Sketch A, for a slender column has reached the point of ultimate failure at the first measurable deflection, if it be originally straight. The late Mr. C. P. Buchanan, who made a series of tests on columns, not slender, described in Engineering News, Dec. 26, 1907, remarked to the writer in discussing his tests that it was surprising what small sidewise deflection a column would stand before failure. It was with the foregoing facts in mind that I said in my letter, "The tie plates do not hinder the bowing action except in an inconsiderable degree."

A slender column whose parts are perfectly straight may reach its ultimate load when it has deflected 1-16-in. or less, whereas a similar column with an original bow of ⅛-in. will stand an additional deflection of ⅛-in. before it fails, both columns failing at the same load. These are facts very easy to demonstrate mathematically on the theory of flexure but very difficult to find in literature on the subject. It is such facts as these that I claim ought to be written into the literature of engineering to displace a lot of "mathematical rot" in the way of complex and meaningless column formulas based on impossible assumptions which totally ignore the practical work of manufacturing a column. Such facts as these would go a long ways toward intelligent design of columns. Such emphasis of the importance and magnitude of slight deflection or bowing in a column has more weight than an abstract dissertation on the impossibility of a rectangle assuming the shape of an oblique parallelogram.

There is a great difference between holding 40 ins. of a column straight with a leverage of 3 ins. (the distance assumed between two rivets of a tie plate) and holding that length of column straight by a triangular system of lattice. In the column under consideration, in 40 ins. of length (the space between tie plates) one tie plate has the work to perform that in a latticed column would be done by 10 or 15 lattice bars. All of these lattice bars would be acting to resist the bowing of the column and all of the 20 or 30 rivets aid in relieving the individual channels of the bending which they would have to take in

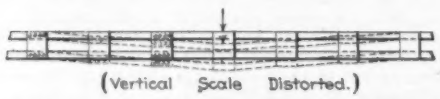
addition to direct stress in the tie-plated column. In this connection I should like to correct a part of my letter which was not printed as I wrote it, as well as a correction which appeared later and was not printed as I wrote it. The figure near the bottom of the second paragraph should be 133,000 and not 263,000. The ultimate strength of this column, it was stated lies between 66,000 and 263,000. The first of these is the ultimate strength with the channels considered pin-ended, the other is four times that amount, or the ultimate strength if the channels are fixed-ended. If the channels were held at the ends with sufficient rigidity to make the points of inflexion seven-tenths of the length apart, the ultimate load theoretically found is just about 133,000 lbs., which is the load at which failure occurred. The investigators assumed this 7/10 pin-ended length, but they applied it to the full column, as though the channels were perfectly connected for transverse shear, and not to the individual channels, as they should have done.

Edward Godfrey.

Monongahela Bank Building, Pittsburgh, Pa., Sept. 7, 1911.

Sir: Referring to letter on the Hamburg gasholder failure, in your issue of July 27, 1911, the following may be of interest:

Stanchions of the tie-plate type have been used in connection with the new station roof here. The stanchions are 25 ft. long and are composed of two 15 × 4-in. by 41.94-lb. channels connected at intervals of 2 ft. by ½-in. plates 12 ins. wide riveted on with four ⅞-in. rivets.



(Vertical Scale Distorted.)

With the idea of testing to what extent the stanchions might be considered integral, I had one laid flat (as a beam supported at each end) and loaded with a concentrated load of 3¼ tons. With the channels on edge the deflection was ⅛-in. full, on a length of 23 ft. 4 ins., and with the channels on flat the deflection was ¼-in. base. From the ordinary formula for deflection the moment of inertia can be deduced which accords with this deflection, and the radius of gyration, as under:

$$I = \frac{wl^3}{48\,ED}$$

If D = deflection

w = load, 3.25 English tons.

$$I = \frac{3.25 \times 280 \times 280 \times 280}{48 \times 12{,}000} \times \frac{4}{1}$$

$$I = 495.6$$

$$r^2 = \frac{495.6}{24.67}$$

$$r = 4.48 \text{ by experiment}$$

Considering the channels as integral, the tabulated min. r is 5.18 ins.

Evidently the form assumed by the stanchion as a beam under test load would be as sketched.

C. E. Shackle, Assoc. Inst. C. E.

G. W. R., Birmingham, Eng., Sept. 1, 1911.

The 1904 Septic-Tank and Filter-Bed Order of the Minnesota State Board of Health.

Sir: In your issue of Aug. 31 you state that some years ago the State Board of Health of Minnesota, by a blanket order, required every municipality in the state to install septic tanks. That is not quite the fact, but the Board did order plans submitted to them for all sewerage. This was in July, 1902, as I have reason to remember, for they hung up all sewerage construction in the state, including two systems I had on hand, one of which was at Canby, where a little work had been done.

They had absolutely no authority whatever to do what they did. As you say, they afterwards abandoned the attempt. True, but not until one of the cities in the state (Northfield, I think) put a crimp in them in the courts, which promptly decided it was none of their business.

The board did not have a cent to pay for legal or engineering or any other kind of advice. I attended a meeting of this State Board. I admit I was sore that they should hang up my work and take away my bread and butter without any authority at law. I said to them: "Why don't you get authority from the Legislature?" The Secretary replied: "They tell us we have more now than we know what to do with." To cap it all the legislature passed a general sewerage law, treating the board with degrading silence, never mentioning them in the act, but authorizing city councils to employ an engineer at their discretion for the work.

It is true, as you suggest, septic tanks were to be the panacea for all sewage ills, and one ——— (a professor in the state university) was the advisor of this state board or its secretary, but this advisor, as far as I could learn at the conclusion of a searching investigation, had never built either a sewer or a septic tank or planned one that was built. When I asked the Secretary where the professor had ever built one, the Secretary laconically replied, he didn't keep track of the private business of the professor.

As to the utter asininity of the septic tank, as applied to Canby or Marshall, Minn., and a dozen other places, it is only necessary to say that a small stream runs through each of these places, which is always a sewer for everybody that can get into it. Even if used as a source of water-supply above, it is a sewer below. At Canby the town was reeking with cesspools and the sewer would have taken the sewage to an outlet below the town, to the detriment of no one.

Naturally, at the time of my fracas with the state board I got into communication with every municipality (there were none in Minnesota) that had a septic tank. In not one case would the operating engineer pronounce one of them a complete success.

Finally, I aver, that the Average Village or City has the same use for a Septic Tank as a Tom Cat has for a Marriage License.

E. T. Abbott.

Thrall, Cal., Sept. 11, 1911.

[The order which we had in mind was issued by the Minnesota State Board of Health in 1904. That order, the 1902 order mentioned by our correspondent, and opinions of the Attorney General of Minnesota giving what he believed to be legal warrant for each order, were printed in our issue of Feb. 11, 1904 (p. 138), forming part of a statement prepared at our request by Dr. H. M. Bracken, Secretary of the Minnesota State Board of Health (then and now). Both the 1902 and 1904 orders were designed primarily for the protection of public water-supplies. The 1902 order required all cities, villages and public institutions contemplating putting in new water plants or sewerage systems, or proposing to repair or extend either, to file statements showing (1) for water, the proposed source of supply and (2) for sewage, "the source and place of discharge."

The filing of plans was required in each case, *only* when purification of the water or of the sewage was proposed, but neither order contained anything about the approval of plans so filed.

The order of 1902 was published as a circular letter dated July 16, 1902, but was given so little attention that, on advice of the attorney general "some pretty positive resolutions" (to quote from Dr. Bracken's article) were passed by the Board on Jan. 12, 1904. These resolutions related to sewage only. The discharge of municipal sewage into any of the waters of the state was declared by the resolution

to be a nuisance and hereby prohibited, unless such sewage is first passed through a septic tank or filter bed, or both, as the case may require, the plans for the construction of said septic tank or filter bed having been first approved by the Minnesota State Board of Health.

This order was to go into effect immediately, except that it was not to apply to sewage from existing drains or sewerage systems until after Jan. 1, 1905. Violation of the law was declared to be a misdemeanor, punishable by a fine of not less than $50 nor more than $100 a day, etc.

Subsequently another attorney general declared this resolution unenforceable.

We referred to this Minnesota incident, in our issue of Aug. 31, 1911, not to condemn the Minnesota Board for its action years ago but rather to commend it for its later action in building up a staff of expert advisers, and also to sound a note of warning to such present-day boards as have not yet learned in the hard school of experience to be reasonably sure they are right before promulgating sweeping orders.

In the very issue which contained Dr. Bracken's article we characterized the resolutions as "radical if not revolutionary," but commended the board on the "underlying principles" on which it was acting, "namely that water pollution is an offense for which every city and village is liable to answer." (p. 128, Feb. 11, 1904).

We devote considerable space to these resolutions in justice to the worthy motives which actuated the Minnesota Board from the start, and which, combined with good judgment and public support, have finally made it one of the most progressive state board of health in the country. We publish Mr. Abbott's letter because it helps to emphasize the point we originally urged (the need of good engineering and other technical advice on the part of boards of health) and also because of the intrinsic interest of the letter.

Finally, it should be understood that we did not intend, in our issue of Aug. 31, to say anything derogatory to physicians or to state boards of health, when keeping within their proper spheres of activity. Nor did we mean to condemn septic tanks; it was the misuse, not the proper use of these, and misconceptions of their function, against which we were protesting.—Ed.]

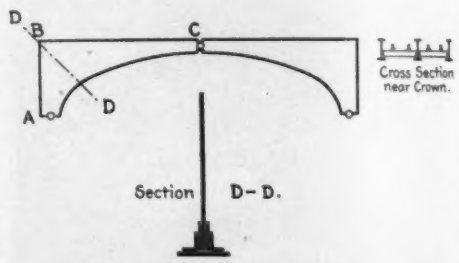
Analysis of Arches of Irregular Outline.

Sir: I am sending you a few points of interest in connection with a design for a three-hinged arch which recently came to my notice.

This arch is of the spandrel-braced type with solid web, examples of which may be found in Rockefeller Park, Cleveland, Ohio. In the design the effect of the web in resisting bending moment was neglected and the top flange was considered as following the line A B C in the accompanying sketch. Flange stresses are not transmitted directly to the pins but must pass through bearing plates. The arrangement and position of the two-angle stiffeners is shown approximately in the sketch.

There are two points in the design, in particular, to which I wish to call attention:

First. It is entirely incorrect to consider A B C as a



continuous flange, and therefore on a Section D–D the arch section consists of a web with a bottom flange attached, as shown in the lower part of the sketch. Here it is evident that the web must certainly be considered as resisting a large amount of bending and the neutral axis is within the toes of the bottom flange angles.

Second. At all sections of the arch the top-flange maximum stresses are very much less than the bottom-flange stresses (flange stresses determined by taking moments about points in the center of gravity of the opposite flange on a section normal to the flange in which the stress is desired). After the maximum stresses in the flanges were determined, the sectional areas were determined by using the maximum allowed unit-stress. It must be evident that in such an arch with a solid web the unit stresses existing under a given loading will not be the same for both top and bottom flanges. We have every reason to believe that, within the elastic limit, a section plane before loading will be quite nearly plane after loading; if any regard is to be had for this consideration, then certainly the areas of the flanges should be first assumed, the relative unit-stresses determined in accordance with the principle just mentioned, and the sections then revised until the areas determined fit both the total flange stresses and the unit-stresses which must exist. The same may be said in considering the design of girders unsymmetrical in regard to the flanges. In the case of the arch above mentioned the top-flange sections will be found too small, since the resultant unit top-flange stress must be less than that for the bottom flange under the loadings giving maximum stresses. The web of the arch as designed will contain stresses the nature of which can hardly be anticipated.

C. A. Melick

1815 East 101st St., Cleveland, Ohio, June 5, 1911.

Reinforced-Concrete vs. Vitrified Clay Pipe for the Roswell Park Pipe Line.

Sir: In Engineering News, June 29, 1911, p. 787, appeared an abstract from a paper read by myself at Twin Falls, Idaho, before the last convention of the Idaho Society of Engineers, descriptive of the Roswell Park reinforced-concrete pipe system, but which appeared in Engineering News under the heading "Building a Reinforced-Concrete Pipe Line in Alkali Soil." In the issue of Aug. 3, 1911, p. 150, appeared a criticism of this paper by Mr. Benjamin Brooks, in which the author wished to know why vitrified clay pipe was not included in the list of eligibles for this installation, the gist of the criticism carrying with it the inference that such form of construction could have been used, instead of the one which was selected, with added safety and economy.

In his criticism Mr. Brooks hints that the selection of concrete instead of vitrified pipe was the fruit of a capricious love of novelty rather than of a conscientious desire to find the best form of construction for the system to be installed. While the wit of the article is admittedly incisive, its logic is so faulty that one is almost forced to the conclusion that Mr. Brooks, in reading the article upon which he assumed to comment somewhat unfavorably, could not have given it more than very superficial consideration; otherwise he would have found in it full answers to nearly all of the questions he asked. On the other hand, since the article was not explicit upon one or two of the points raised, the following explanations are offered in answer.

In considering types of construction for the Roswell Park main pipe line the writer did not think that it would be good practice to adopt any form of pipe designed with a safety factor of less than four against the tensile stresses that would be encountered; and in no case did he think that either a concrete or vitrified pipe should be used, exposed to pressure due to a head of more than 10 ft., without some form of steel reinforcing. The profile showed that fully 90% of the line would have a head greater than 10 ft., and 75% of it would have a head of 60 ft. or more. This called for a reinforced pipe for practically the entire line, and as a matter of general safety no part of the pipe was left unreinforced.

From this it will be seen that, since a reinforced pipe was indicated, and no method of reinforcing vitrified pipe had been suggested within a cost that would bring it into competition with concrete pipe, one does not have to search very far to find at least one very strong reason why vitrified pipe should be rejected for this particular piece of work. Since the article was not full in that it did not give the profile of the line, it did furnish such figures that Mr. Brooks was led cautiously to admit that a pressure of 30 lbs. is "a high one to put upon either vitrified clay or concrete pipe without additional strengthening"; but he adroitly saves himself for vitrified pipe by suggesting that such pipe be used, but encased in another pipe of reinforced concrete. From the above explanation of the profile it will be seen that this would have meant the construction of practically the entire line in the form of a monolithic reinforced-concrete pipe, with a lining of vitrified clay pipe. Possibly this might have made a serviceable pipe, but the query would at once suggest itself why not make the concrete pipe without the vitrified lining? Possibly the shell of the casing might be able to be made somewhat thinner than would be necessary for a pipe without such lining, but this saving would be more than offset by the added diameter necessitated by the introduction of the lining. Mr. Brooks suggests that the vitrified lining would increase the discharge capacity by lowering the coefficient of friction, but this has been very ably shown by Mr. Gustave Kaufman, in his comment upon Mr. Brooks' letter in Engineering News, Aug. 24, 1911, p. 238, to be very questionable; and it is the decided opinion of the writer that in a pipe so long as this one, for the reasons given by Mr. Kaufman, and others, that the coefficient of friction would be raised rather than lowered. Mr. Brooks further thinks that the introduction of the vitrified lining would protect the pipe from the percolation of alkali water through it; but it is very difficult to follow his reasoning, in view of the fact that the article which he criticises very clearly states that for two distinct reasons water does not percolate through it, in the form in which it is already constructed. It is there shown that upon test of the pipe under a head of 70 ft. there was not even a sweating of the pipe from within outward, while the line is so effectually subdrained and side-drained that alkali water cannot penetrate it from without. The small amount of water which has reached it in precipitation has only had the effect of leaching off into the subdrain what little alkali was in the soil in contact with the pipe.

This reduces Mr. Brooks' argument to a matter of relative cost. His assumptions in this item do not correspond with the writer's conclusions. The contract price at which the pipe actually constructed was built, independent of trenching, hauling and backfilling, was $3.25 per lin. ft. The best estimate that could be secured for the corresponding work on a monolithic pipe was about $4.50 per lin. ft. If the latter were built with the vitrified lining, the cost of the core added to that of the increased diameter involved would much more than offset the gain through reduction in the thickness of the shell and the elimination of wooden or steel forms, hence there could be no argument on the ground of cost in favor of the monolithic construction. Other reasons why a monolithic form was rejected are given in the original article.

Mr. Brooks goes into a somewhat detailed citation of statistics to show that vitrified pipe is less porous than concrete pipe. For instance, he quotes from the report of the Brooklyn Bureau of Sewers, "Percolation through vitrified pipe usually commences at a pressure of 5 lbs. per sq. in., equivalent to a head of 11.5 ft. It increases very slowly as the pressure increases to the point of bursting, which is usually at or above 40 lbs. per sq. in." True enough, possibly, but what advantage does such a pipe offer over one which does not percolate at all under a head six times as great as the above? Of what use would a pipe that will burst at 40 lbs. be where one is required to furnish a safety factor of four against a pressure of 30.4 lbs., which would require a resistance to 121 lbs. at the lowest part of the pipe, and to 104 lbs. throughout 75% of the line? The absurdity of such comparisons will be still further apparent when it is explained that the specifications for the Roswell pipe called for a safety factor of four in the reinforcing, the tensile strength of the concrete being disregarded. In order to make a vitrified pipe equally safe the full safety factor would have to be thrown into the concrete casing, which would place Mr. Brooks in the very illogical position of recommending for the entire pipe a form of concrete construction which is clearly shown above to possess few of the advantages of the pipe that was selected, but many disadvantages, which were considered more than sufficient to call for its rejection.

It may be noted that Mr. Brooks' greatest grievance seems not to be that concrete was finally selected for the Roswell pipe, but that vitrified pipe was not given a fair show in the competition; and he may argue that the writer could not have foreseen that a concrete pipe was going to prove to be entirely watertight under a head of 70 ft., considering that such eminent authorities as he quotes had conclusively proved that it was more porous than even vitrified pipe which had begun to sweat at a head of 11.5 ft. His reasoning would again be fully as faulty as in the above instances. Before designing the Roswell pipe the writer had visited the Government reclamation works at Hermiston, Ore., on the Umatilla project, and had seen concrete pipes of practically the same diameter as that of the proposed pipe, working under nearly the same head, without showing the least sign of leakage. He certainly never had seen a 36-in. vitrified pipe, 4,500 ft. long, working under an equivalent head without leaking, and for some mysterious reason, even while accusing the writer of being governed by a love of novelty, Mr. Brooks very discreetly refrains from citing any successful installations of that kind.

The writer does not profess to be versed in all of the history of the use of vitrified pipe in the East, but in the West it has been his experience that it is very difficult to make a watertight joint for vitrified clay pipe, even where the pressure is light. Some seemingly successful installations of such pipe as water mains have been cited in Engineering News, but it will be noted that in these cases the head was only about 9 ft., which is a very different proposition from a head of 70 ft. Even leaving the questions of porosity and tensile strength out of consideration, if any cases are on record in which watertight joints have been made for vitrified pipe working under so high a head, at anything like a reasonable cost, they have not come to the notice of the writer.

Furthermore, it is not at all clear by what license Mr. Brooks assumes to state that the joint of pipe which has been kept immersed in the alkali slough for experimental purposes was a "specially-made length," and that full reliance was placed upon the action of the alkali upon this joint. If Mr. Brooks had taken the precaution to read the article which he has criticised he would have been very plainly informed that both of these assumptions are at direct variance with the facts. This length of pipe was in no sense a "specially-made length," but one taken directly from the manufacturing plant, and made precisely as were the joints actually built into the line; and far from placing full reliance upon it, the original article shows that even before the type of the pipe was decided upon "concrete manholes in sewers, and concrete foundations . . . which had stood for years exposed to the action of alkali in its worst form, or at least the worst form known to these localities, were carefully examined, but no trace of injury thereto could be discovered."

To be more explicit on this matter of the action of alkali upon the pipe, the joint of pipe under examination was not freed from any of the adverse conditions to which the constructed line was exposed, but it was called upon to undergo them all, and a lot more besides. This is very clear from the fact that the constructed line does not carry water impregnated with alkali, so if the contained water did percolate from within outward, which is not the case, it could do no harm. It cannot percolate from without inward, since the drains prevent it from reaching the pipe. In the case of the test joint it can do both. It may be of interest to know that this test joint has now been in the alkali slough for more than a year, but upon a recent examination there was still no trace of injury to it by the alkali. The writer's conclusion in this matter is that the reason for this, in contrast to the vicious effect that has been noted by various observers from time to time, is found in a difference in the nature of the alkali in the different instances, or a difference in the amount of free lime left in the concrete, which has resulted in crystallization and mechanical disruption in some cases, while in others such effect has not developed.

Under other conditions, therefore, the owners of the Roswell pipe line might be grateful to Mr. Brooks for his sympathy for their alleged loss of sleep, but if Mr. Brooks knows of their having been grievously afflicted with insomnia he has been in closer touch with them than the writer, who has been their consulting engineer from the inception of work on their project. So far as he knows their slumbers have been sweet as those of a new-born babe.

Zenas N. Vaughn, Chief Engineer.
Roswell Park Reinforced-Concrete Pipe System.
Boise, Idaho, Sept. 11, 1911.

The Comparative Designs of Reinforced-Concrete Floors.

Sir: Mr. K. R. Schuster's second letter with the above title which appeared in Engineering News, Sept. 21, 1911, p. 346, indicates that he still misinterprets certain clauses in the Chicago Building Ordinance. The writer thought that he had made this clear in his letter of Aug. 31, 1911, p. 264, but it seems that such is not the case.

Quoting another section in the Ordinance may elucidate matters. "For square or rectangular slabs, the distribution of the loads in the two directions shall be inversely as the cubes of the two dimensions." For a square panel one-half of the total load would be distributed in each direction, of course. Using a bending moment of $\frac{1}{12} wl^2$ in which w is the above half total load per sq. ft., each set of reinforcement was calculated as if the slab was supported on two sides only. This amounts to the same thing as far as steel and concrete is concerned as figuring a bending moment of $\frac{1}{24} wl^2$, in which w is the total load per sq. ft., and in which the steel thus found is the same in both directions. Mr. Schuster can rest assured that this is the correct interpretation of these clauses in the Ordinance, as the writer is in a position to know.

The writer does not believe for a moment that Mr. Schuster deliberately distorted the Ordinance to fit his individual ideas, but rather thinks that Mr. Schuster and the Chicago Building Ordinance do not perfectly agree.

It was not the intention of the writer to enter into a discussion of the Ordinance. Wrong or right he designed his work in conformity with that code of laws. The writer has had sufficient

experience to know that it is generally advisable to stick pretty closely to building laws or any other restrictions which may be imposed.

J. Norman Jensen.

1518 N. Leavitt St., Chicago, Ill., Sept. 23, 1911.

Formula for Continuous Girders Under Partial Loading.

Sir: While there are formulas for continuous girders of any number of spans each loaded its entire length with a uniform load, and also formulas for continuous girders with any number of concentrated loads, I have been unable to find an expression for girders in which only part of one

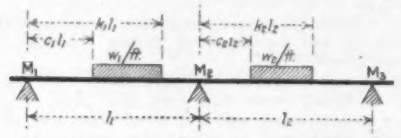


Fig. 1. General Case of Continuous Girder With Partial Distributed Load in Two Spans.

span (or parts of any number of spans) is loaded with distributed load. This problem is covered by the formulas given below.

For concentrated loads on spans l_1 and l_2, the loads being distant $k\,l$ from the left-hand end of the respective span, we have the expression,

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -\Sigma P_1 l_1^2 (k - k^3) - \Sigma P_2 l_2^2 (2k - 3k^2 + k^3)$$

To apply this formula to partial distributed loading, Fig. 1, let $P_1 = w_1 \times l_1\,dk$, being the load at the rate of w_1 per foot on an element of length $l_1\,dk$; and similarly make $P_2 = w_2 \times l_2\,dk$. Then, writing M for the left-hand side of the equation, we have

$$M = -w_1 l_1^2 \int_{c_1}^{k_1} (k - k^3)\,dk. - w_2 l_2^2 \int_{c_2}^{k_2} (2k - 3k^2 + k^3)\,dk$$

$$= -w_1 l_1^2 [\tfrac{1}{4} k_1^2 (2 - k_1^2) - \tfrac{1}{4} c_1^2 (2 - c_1)^2] - w_2 l_2^2 [\tfrac{1}{4} k_2^2 (2 - k_2^2) - \tfrac{1}{4} c_2^2 (2 - c_2)^2]$$

which is the general expression.

Applying this formula to special cases: For full uniform load on both spans, $c_1 = c_2 = 0$ and $k_1 = k_2 = 1$, which gives

$$M = -\tfrac{1}{4} w_1 l_1^2 - \tfrac{1}{4} w_2 l_2^2$$

or the common expression for a continuous girder loaded with full uniform load. For Case 1 of the

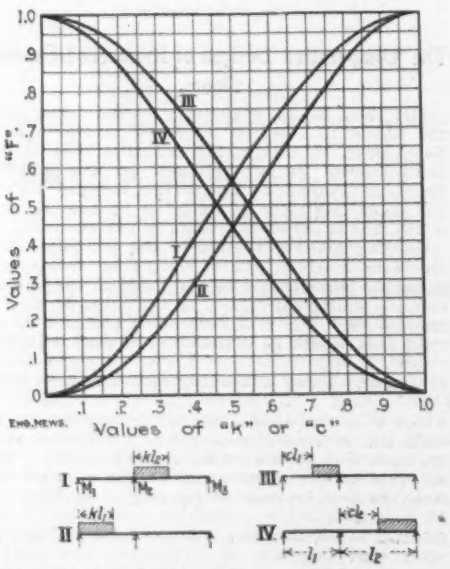


Fig. 2. Curves of Coefficients for Continuous Girder With Partial Distributed Load in One Span.

Ordinates are values of F in formula
$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = \tfrac{1}{4} w l^3 F.$

accompanying diagram, Fig. 2, we have $c_1 = k_1 = 0$, and $c_2 = 0$, which gives

$$M = -\tfrac{1}{4} w_2 l_2^3 k^2 (2 - k)^2 = -\tfrac{1}{4} w_2 l_2^3 F$$

The value of the factor F for varying values of k is given in Fig. 2.

Similarly for Cases II, III and IV of Fig. 2 we have

Case II, $F = k^2 (2 - k^2)$,
Case III, $F = 1 - c^2 (2 - c^2)$,
Case IV, $F = 1 - c^2 (2 - c)^2$,

which formulas are also plotted in Fig. 2, on a base representing either c or k.

C. W. Yelm.

2746 Olive St., Kansas City, Mo., Aug. 16, 1911.

The Position of the Engineering Profession.

Sir: Referring to the editorial on "What can the Engineering Profession do to Improve its Position?" in your issue of Aug. 17, I agree with you in every recommendation which you have made. It is a matter of the utmost importance and I certainly hope that some definite action may result from the thought which must have been aroused in the minds of many engineers upon reading your editorial.

I also wish to commend very highly your editorial on "The Treatment of the Young Engineer." It seems to me futile for the older engineer to expect that he will be treated as he should be if he himself is unwilling and in his practice does not properly treat the young and inexperienced engineers who are employed by him. As an educator, I do not desire that young engineers shall be shielded from good hard work. This is absolutely essential for their development, but they may well claim some attention on the part of their employers. Sometimes good straight advice, a fatherly talk in the office for a half hour may wonderfully change the quality of the work and the general spirit toward his work of the young man. The Chief Engineer likewise should see to it that adequate remuneration is obtained for those under his direction when that payment is made directly by some corporation, municipality, etc. You deserve the thanks of everyone related to engineering practice for these and other splendid editorials which have recently appeared.

Very truly yours,

Henry S. Jacoby.

Ithaca, N. Y., Sept. 19, 1911.

Computing the Charge Required for Effective Blasting.

Sir: In looking over Engineering News for May 5, 1910, I found a report and a diagram of a blast, shot at Linton, Ore., in which the writer, Mr. J. C. Costello, makes the following statement:

The coyote hole was loaded under direction of the writer and the amount of powder used, as well as the proportions for each load, was precisely calculated, so that the formation did not rise or throw at all."

If Mr. Costello or any other reader of Engineering News can inform me of a precise method of calculating the proper amount of explosive to be used under given conditions, they will confer a favor. The majority of reports on blasting say that so much explosive was used, without stating why, and the only result of my inquiries among engineers and rock foremen has been, "Experiment until you find a good load." This method may be safe, but it is rather expensive.

Yours truly. E. L. Huser.

Faust, N. Y., Sept. 15, 1911.

[It may be said with safety that there is no *precise* method of computing the exact load required to break up a mass of rock without throwing it. Men of long practical experience in blasting, however, are able to judge pretty well how much explosive is required to accomplish the desired work without wasting money in needless firing of powder. We shall be glad to give space to any practical rules developed by experience which any of our readers may be able to contribute.—Ed.]

Notes and Queries.

L. W. S., San Francisco, writes: "Can you produce from engineering literature any example of clarity of expression and accuracy of information superior to the following clipping, taken from the query column of a San Francisco newspaper?"

Valves—C. T. H., Berkeley. Why is it that sections of pipe used in connection with the auxiliary fire water system in San Francisco are smaller at one end than the pipe they are connected with?

At every crossing there is a hydrant connected by one of the small pipes you refer to. The pipe is made smaller at one end in order to reduce the pressure.

"This should make C. T. H. a sadder if not a wiser man.

"The writer has been connected with the design and construction of the "auxiliary fire water system" for over two years, but confesses his inability to comprehend either the question, the answer, or the connection of the title with either."

A subscriber at Manchester, England, referring to the description, in our issue of Aug. 24, of a large fan for blowing air into the humidifier in connection with a cotton mill, calls our attention to the fact that the fan described, while very large for building ventilation, is surpassed by many fans used for mine ventilation. He refers to one mine fan in operation near Rotherham, Yorkshire, England, which has a revolving wheel 40 ft. in diameter and 12 ft. face. The wheel is carried by a shaft 15 ins. in diameter, and runs at 40 r.p.m. Similar large mine ventilating fans are in extensive use both in Europe and America.

The Properties of Douglas Fir; A Study of a Structural Timber.

Douglas fir, known variously as red fir, Oregon pine, red pine, etc., is one of the most important structural woods in this country. At present it ranks second only to southern yellow pine in production, and its rapid growth and wide distribution along the Pacific coast make it probable that soon it will pass even that valuable timber. Of a straight grain, strong, hard and fairly durable, it lends itself to a great variety of uses, from the finer forms of cabinet work to the heaviest structural members. During the past seven years the United States Forest Service has been engaged in an experimental study of the properties of this wood, the results of which are embodied in a recent bulletin* by Messrs. Cline and Knapp, of that service. Besides summarizing the tests of the physical qualities of the wood, the bulletin contains much other valuable matter of general interest in timber study, though all the deductions are based on the behavior of Douglas fir. These matters include the effect of physical characteristics on mechanical properties, with especial reference to the difference in strength of large and small-size pieces, the variability of different pieces of the same wood and the question of the insufficiency of most grading specifications. We have prepared below an abstract of the salient features of the bulletin.

Mechanical Properties of Douglas Fir.

TESTS.—The tests may be divided into two general classes:

1. Tests on bridge stringers and car sills containing knots, checks, and other defects ordinarily encountered in such material purchased in the open market. The car sills were 5 x 8 ins. in cross section and the bridge stringers 8 x 16 ins. in cross section. Both were tested over a 15-ft. span. The purpose of these tests was to secure moduli for design and to determine the influence on the strength of structural timbers of knots, checks, and other defects that distinguish one grade of material from another, and also to determine the influence of seasoning on the strength of structural timber.

2. Tests on small-sized specimens free from defects, such as knots, checks, etc. The purpose of these tests was to study the influence of such factors as rate of growth, per cent. of summerwood, and moisture content on the strength of wood. Such factors can not be studied when the results of the tests are greatly influenced by the presence of defects which commonly occur in large pieces. These tests are also useful in showing the relation existing between the properties of specimens free from defects and those containing knots, checks, cross grains, etc.

The tests may be further divided into four classes:

1. Bending tests to determine the cross-breaking strength of the wood, made on both bridge stringers and car sills and on pieces 2 x 2 x 30 ins.

2. Tests to determine the strength of the wood in compression parallel to grain, made on specimens 6 x 6 x 24 ins. and 2 x 2 x 8 ins.

3. Tests to ascertain the strength in compression perpendicular to grain, made on pieces 8 x 16 ins. and 5 x 8 ins. in cross section, taken from the bridge stringers and car sills tested.

4. Shearing tests, made on small clear specimens only.

All of these tests were made on a universal testing machine of sufficient capacity to rupture the largest test pieces used. From a great num-

*"Properties and Uses of Douglas Fir," by McGarvey Cline, Director, Forest Products Laboratory, and J. B. Knapp, Assistant District Forester. Bulletin 88, U. S. Department of Agriculture, Forest Service, 76 pp.

ber of such tests the following average results were obtained (Table I-II):

By careful air-seasoning to a moisture content as low as 15% the strength of small clear specimens may be increased approximately 35%.

For purposes of comparison the bulletin presents a table showing the properties of various kinds of structural woods, distinguishing between the strengths as found in large and in small-size pieces. This table is given herewith as Table III. The figures in boldface type are the results on large specimens, the other figures the results on small specimens free from defects.

Variation of Physical Quality.

The tests showed that Douglas fir varied greatly in physical properties, although fully representative material was chosen. This is graphically illustrated by a number of diagrams, two of which are reproduced herewith in Fig. 1. These diagrams are explained as follows:

The areas of the various cross-hatched diagrams are equal, and in each diagram the total area represents the total number of specimens tested.

The area between adjacent horizontal lines represents graphically the percentage of the total number of tests that fell within the limits indicated on the scale to the left. The percentage is expressed numerically by the figures within the cross-hatched areas. For example, by referring to the crushing strength diagrams for small and large beams (Fig. 1) it will be seen that, in the case of small beams, 12% of the tests fell between 105 and 110% of the average strength. In the case of the large beams, 10% of the tests fell between the same limits.

The figures on the left edge of the diagram sum up the percentages within the cross-hatched areas, starting from the 100% line; while those to the right sum up the percentages starting, respectively, from the maximum and minimum points. These scales facilitate the use of the diagrams. For example, again referring to the diagram, by using the scale to the left it will be seen that 39% of the tests on small beams fell within 100 and 120% of the average. In the case of large beams, 34% of the tests fell within these limits. By using the scale to the right of the diagram, it is seen that 11% of the tests for small beams were higher than 120% of the average. In the case of the large beams, 16% of the tests were higher than 120% of the average.

It may also be noted from the diagram that in large-size pieces 6% of the pieces tested have compression parallel to grain values between 60

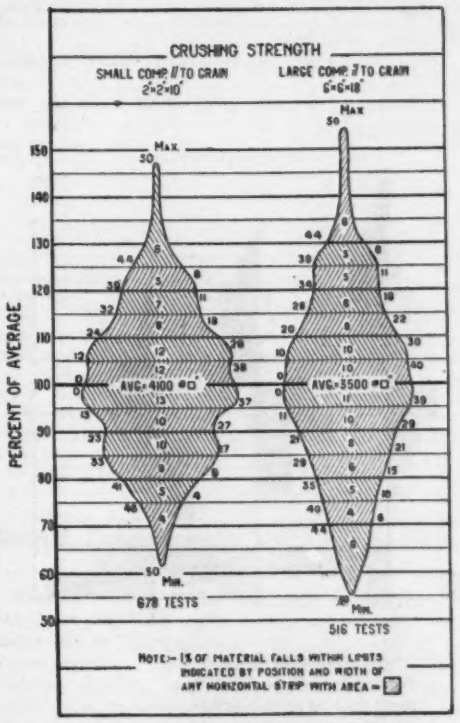


Fig. 1. Typical Diagram Showing Variability in Test Pieces of Douglas Fir.

and 70% of the average and 6% have values between 130 and 150% of the average. If these pieces were used in practice their factors of safety would vary considerably from that derived from an average compression value.

Relation of Physical Characteristics to Mechanical Properties.

The wide variation in the mechanical properties of Douglas fir suggests the possibility of judging the relative strength of different pieces by an inspection of their physical characteristics. The elements which might be used for this purpose are: (1) color, (2) weight, (3) proportion of summerwood, (4) rate of growth, (5) defects, such as knots and cross grains.

These were all studied with the following conclusions: (1) The difference in strength between red and yellow fir is not enough to warrant a discrimination in favor of either. (2) Dry weight is of great significance in judging the relative strength of different pieces of Douglas fir; the heavier the wood the higher its physical resistance. Since, however, the dry weight cannot be obtained very readily, this relation is of little practical importance in the grading of commercial timbers. (3) An increase in summerwood means an increase in weight and consequently an increase in strength, but as in large pieces there is such a wide variation in the percentage of summerwood in the different parts of the cross-section, this relation is also of very little practical value. (4), Average rate of growth has little significance in grading structural material.

This leaves only the defects to be investigated. The defects encountered in Douglas fir lumber may be classified as pitch seams and shakes, cross-grain and knots. Where pitch seams are large it is reasonable to suppose they may cause weakness, but in none of the specimens tested were they extensive enough to prove detrimental to strength. It was observed that beams showing cross-grain to marked extent were almost invariably weak.

It was much more difficult to investigate the matter of knots on account of the complications of their position, size, number and the condition of the wood around them, but an effort was made to do so by testing in shear and compression blocks containing knots and in bending, small beams containing knots in certain segregated places.

It was found that knots do not decrease the shearing strength of the wood, but rather tend to increase it by acting as pins, thus preventing the sliding of one surface over the other. It was found, however, that the presence of knots appreciably decreases the strength of Douglas fir in compression parallel to grain, the decrease being approximately 22% in the case of knots greater than 1½ in. in diameter, 14% for knots between ½-in. and 1½ ins. in diameter, and 6% in the case of knots ½-in. in diameter. In cross-bending of beams, the pieces were graded by the position and size of the knots, varying from clear to scattered knots in all parts of the beam. In these pieces the following points were noted:

The modulus of elasticity for large beams and that for small clear beams cut from them are approximately equal. This would seem to indicate that the modulus of elasticity is not influenced by the presence of defects in the large specimens; in other words, knots do not affect the stiffness of Douglas fir timbers, this factor apparently being dependent almost entirely upon the quality of the clear wood.

The fiber stress at elastic limit for large beams does not vary with their modulus of rupture, but is, with very few exceptions, practically equal to the crushing strength of the small clear specimens. This is an extremely significant fact, because it indicates that the elastic limit of Douglas fir beams is not greatly affected by the presence of knots. However, in the car sills having a low modulus of rupture, the elastic limit usually falls below the crushing strength of the clear wood, while in the sills having a relatively high modulus of rupture the fiber stress at elastic limit frequently exceeds the crushing strength of small clear specimens. This would apparently indicate that the elastic limit is but slightly influenced by the presence of defects.

By comparing the modulus of rupture figures for large beams with the modulus of rupture and crushing strength of small clear specimens, it will be seen that in the beams clear of knots the modulus of rupture is considerably higher than the crushing strength of the clear wood, and falls approximately midway between this function and the modulus of rupture for small beams. As the number and seriousness of the defects in the large beams increase the modulus of rupture approaches in value the crushing strength of the clear wood and the elastic limit of the beam. In the low-grade material there is very little difference between the modulus of rupture of large beams and their elastic limit and the crushing strength of the clear wood. As the modulus of rupture of the large beams approaches in value the crushing strength of the clear wood, the difference between it and the modulus of rupture of the small clear beams increases. These relations indicate that the presence of knots influence most the breaking strength of the beams in which they occur.

In the clear beams the modulus of rupture is almost 50% greater than the fiber stress at elastic limit and crushing strength; this fact would seem to indicate that the principal effect of knots upon timber beams is to decrease the energy required to break the beam after the elastic limit is reached. The ability to resist rupture after the elastic limit is passed indicates toughness.

Large knots and knots in great numbers are associated with and indicative of poor wood. This is shown by a gradual decrease in the modulus of rupture of small clear beams and

TABLE I.—RESULTS OF TESTS ON 8 × 16-IN. × 16-FT. DOUGLAS FIR BRIDGE STRINGERS.

	Fiber stress at elastic limit, lbs. per sq. in.	Modulus of rupture, lbs. per sq. in.	Modulus of elasticity, 1,000 lbs. per sq. in.
Selects:			
Green	4,346	6,753	1,654
Air-dry	4,690	7,070	1,644
Merchantable:			
Green	3,895	5,878	1,481
Air-dry	4,625	6,472	1,567
Seconds:			
Green	3,538	5,188	1,328
Air-dry	3,740	4,551	1,280
All grades:			
Green	4,000	6,000	1,510
Air-dry	4,467	6,327	1,540

TABLE II.—RESULTS OF TESTS ON SMALL CLEAR PIECES OF GREEN DOUGLAS FIR.

	Pounds per sq. in.
Bending:	
Fiber stress at elastic limit	5,500
Modulus of rupture	8,400
Modulus of elasticity	1,600,000
Compression parallel to grain:	
Crushing strength at elastic limit	3,600
Crushing strength modulus of elasticity	4,100
Shearing	770

TABLE III. LARGE AND SMALL-SIZE TEST VALUES OBTAINED BY THE U. S. FOREST SERVICE ON VARIOUS STRUCTURAL WOODS.

Full-face type = large specimens.
Light-face type = small specimens.

Species.	Weight per cubic foot-pound.		Bending.			Compression parallel to grain.		Compression perpendicular to grain.	Shear.
	Air-dry weight.	Oven-dry weight.	Fiber stress at elastic limit	Modulus of rupture.	Modulus of elasticity.	Compressive strength at elastic limit.	Crushing strength at maximum load.	Compressive strength at elastic limit.	Shearing strength.
	Lbs. per cu. ft.	*Lbs. per cu. ft.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*1,000 lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
Longleaf pine	41	36	3,800	7,200	1,560	3,500	4,800	570	
			5,000	9,100	1,540				970
Douglas fir	33	29	4,000	6,000	1,510	2,800	3,500	370	
			5,500	8,400	1,600	3,600	4,100		770
Loblolly pine	36	31	3,200	5,000	1,430	2,400	3,500	470	
			4,100	7,900	1,440		4,100		630
Shortleaf pine	35	30	3,300	5,000	1,470	2,500	3,400		
			4,400	7,700	1,400		3,600	400	710
Western hemlock	32	28	3,700	5,600	1,230	2,800	3,700	480	
			5,200	7,900	1,360	3,700	4,100		750
Western larch	38	30	3,500	5,400	1,410	2,600	3,700	480	
			4,600	7,500	1,370	3,200	3,800		700
Tamarack	35	30	2,900	4,600	1,220	2,400	3,200		
			3,300	5,800	980		3,200		670
Norway pine	29	25	2,600	4,000	1,190	2,000	2,600		
			2,800	5,200	960		2,500		660

in the crushing strength of clear specimens cut from the lower grade timbers containing such knots. As the quality of the wood fiber thus decreases, a general dropping off in the compressive strength and the fiber stress at elastic limit is observed. It is noticeable that even in the beams having a very low modulus of rupture, when the tests on small clear specimens indicate a good quality of fiber, the elastic limit of the beam and its modulus of elasticity are almost invariably higher than they are in beams having approximately the same breaking strength, but in which the quality of the wood fiber is poor.

The average properties of clear beams are considerably higher than the average for the other classes containing defects more or less serious in character. The range indicated by the maximum and minimum values, however, is practically as great in clear material as it is in material containing defects, thus indicating that clear material is sometimes weaker than material containing knots.

In each of the other classes in general the size of a knot is significant in determining its influence upon the strength of the timber in which it occurs.

Knots in the middle half of the bottom face of a beam are considerably more serious than knots in other parts of the stick.

Grading Rules and Specifications.

Grading rules and specifications for structural timbers are, primarily, for the purpose of classifying them on the basis of strength and durability. Engineers until recently, however, have given very little consideration to specifications for such timber. A few years ago it was possible to secure the highest grade material at a very moderate cost, and early specifications almost invariably called for material free from such defects as might even be suspected of impairing its strength and durability.

With the increased consumption of lumber and the rapid depletion of supply of high-grade material available for structural purposes, the user of structural timber has been forced to modify specifications and to accept material which a few years ago would have been rejected. It is reasonable to suppose that further modification will have to be made with changing conditions of supply and demand.

Almost without exception structural timber is graded in a green condition. On this account the following comparison of different grading rules and specifications for Douglas fir is based on data secured from tests on green material. The comparison is of interest in that it indicates along what lines specifications and grading rules can be modified to the best advantage.

The following specifications and grading rules for Douglas fir in structural sizes are typical of those now in use:

SPECIFICATION A.—Used by one of the leading transcontinental railway systems:

All timber must be of the best description of the kind required. It must be sawed square and to proper dimensions. It must be free from all loose, large, or unsound knots, sap, sun cracks, shakes, wanes, or other imperfections or defects which would impair its strength or durability.

SPECIFICATION B.—Used by one of the leading railway systems operating east of the Mississippi River:

Fir stringers, bridge ties, and plank.—Must be from good, sound, live, straight and close-grained Douglas fir, sawed square edge and true to dimensions ordered, free from splits, shakes, loose, rotten, or grouped knots and other defects. Sound knots 2 ins. in diameter or less will be permitted if not less than 4 ins. from the center of the knot to any edge. Ninety per cent. of the stringers and ties must be free from sap. Ten per cent may have sap not in excess of 2 ins. on each of the two edges only.

SPECIFICATION C.—Isthmian Canal Commission:

Stringers of Douglas Fir.—Shall show not less than 85% heart on any face and not less than 70% on any edge; it shall show not less than an average of 12 annual rings to the inch. Sound knots less than 3 ins. diameter shall be permitted in the vertical faces of the stringer at points not less than one-fourth the depth from the edge of the piece.

SPECIFICATION D.—Export grading rules of the Pacific Coast Lumber Manufacturers' Association, adopted 1903:[1]

Selects.—Shall be sound, strong lumber, good grain, well sawed. Will allow in sizes 6 × 6 ins. and less, knots not to exceed 1 in. in diameter; sap on corner one-fourth the width and one-fourth the thickness; small pitch seams not exceeding 6 ins. in length. In sizes over 6 × 6 ins., knots not to exceed 2 ins. in diameter, varying according to the size of the piece; sap on corner not to exceed 2 ins. on both face and edge; pitch seams not to exceed 6 ins. in length. Defects in all cases to be considered in connection with the size of the piece and its general quality.

Merchantable.—This grade shall consist of sound, strong lumber, free from shakes, large, loose, or rotten knots, and defects that materially impair its strength; well manufactured and suitable for good substantial constructional purposes. Will allow occasional variations in sawing or occasional scant thicknesses, sound knots, pitch seams, and sap in corners, one-third the width and one-half the thickness. Defects in all cases to be considered in connection with the size of the piece and its general quality.

Seconds.—This grade shall consist of lumber having defects which exclude it from grading as merchantable. Will allow knots and defects which render it unfit for good substantial constructional purposes, but suitable for an inferior class of work.

SPECIFICATION E.—This specification was tentatively adopted by the American Railway Engineering and Maintenance of Way Association and by the American Society for Testing Materials. It has also been adopted by the Yellow Pine Manufacturers' Association as a basis for grading yellow pine bridge and trestle timbers:

[1]These rules have been modified since their adoption, but the changes have been made to express the conditions with greater clearness rather than to indicate a different quality of timber. The rules quoted were in force when the material used in these tests was selected and graded.

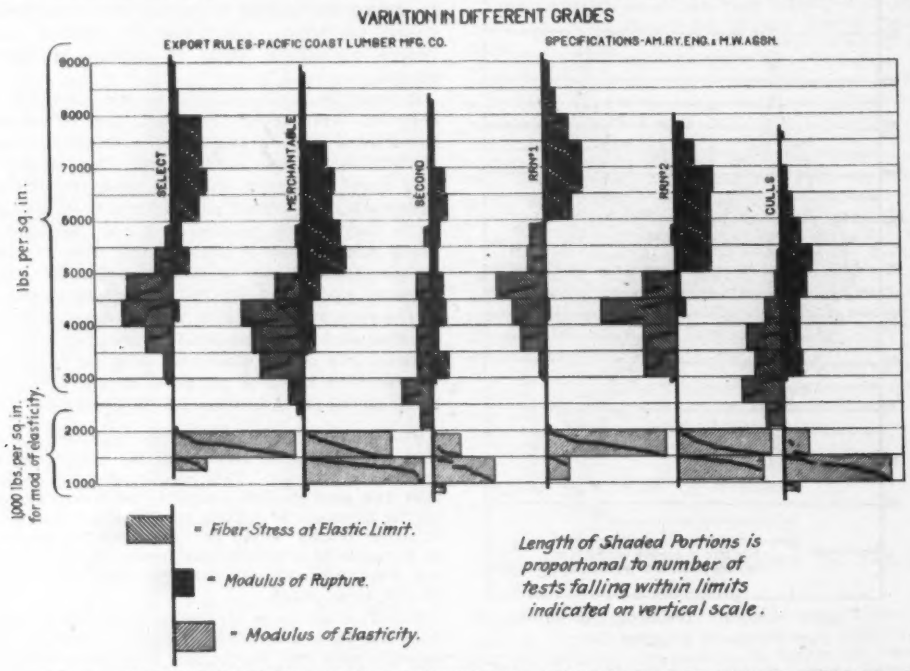


FIG. 2. DIAGRAM SHOWING THE GROUPING OF DOUGLAS FIR STRINGERS TESTED, ACCORDING TO SPECIFICATIONS D & E.

Standard specifications for bridge and trestle timbers—

To be applied to solid members and not to composite members.

1. General requirements: Except as noted all timber shall be cut from sound trees, true and straight, and sawed standard size; shall be square edged, close grained, solid and out of wind; free from defects such as injurious ring shakes and crooked grain, unsound or loose knots, knots in groups, decay, large pitch pockets, or other defects that will materially impair its strength.

2. Standard size of sawed timber: Rough timbers sawed to standard size means that they shall not be over ¼-in. scant from the actual size specified. For instance, a 12 × 12-in. timber shall measure not less than 11¾ × 11¾ ins.

3. Standard dressing of sawed timber: Standard dressing means that not more than ¼-in. shall be allowed for dressing each surface. For instance, a 12 × 12-in. timber after being dressed on four sides shall measure not less than 11½ × 11½ ins.

No. 1 railroad grade—Longleaf yellow pine and Douglas fir—

4. Stringers: Longleaf pine shall show not less than 85% heart on the girth anywhere in the length of the piece; provided, however, that if the maximum amount of sap is shown on either narrow face of the stringer, the average depth of sap shall not exceed ½-in. Douglas fir shall show not less than 90% heart as measured above. Knots greater than 1½ ins. in diameter will not be permitted at any section within 4 ins. of the edge of the piece.

No. 2 railroad grade—Longleaf and shortleaf yellow pine, Douglas fir, and western hemlock—

10. Stringers: Shall be square edged, except they may have 1-in. wane on one corner. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

To determine the effectiveness of the different grading rules and specifications quoted an attempt was made to apply them to the 175 green bridge stringers tested.

SPECIFICATION A.—The wording of Specification A is so general that it practically leaves the whole question of grading to the judgment of the inspector. With an efficient inspector such specifications frequently give very satisfactory results, both to the purchaser and to the seller. Results secured from its application, however, will vary with the judgment of the inspector, and on this account the use of such specifications is frequently the cause of more or less serious misunderstanding. It was thought impractical to use this specification in grading the material tested. It is cited merely as being typical of a class of specifications in use.

SPECIFICATION B does not allow knots more than 2 ins. in diameter, and no knots at all are permitted unless the center of the knot is at least 4 ins. from the edge. Only 19 of the 175 stringers tested passed this knot specification, indicating that it is by all means too severe.

The average fiber stress at elastic limit, modulus of rupture, and modulus of elasticity of the stringers passing this specification were, respectively, in pounds per square inch, 4,887, 7,414 and 1,728,000. The maximum value of these functions were, respectively, 5,850, 8,890, 1,945,000, while the minimum values were, respectively, 4,100, 6,440 and 1,523,000.

SPECIFICATION C.—The pertinent provisions of this specification are (1) that the average rate of growth shall not be less than 12 rings per in.; (2) knots greater than 3 ins. in diameter are not allowed; (3) knots less than 3 ins. in diameter are permitted on the vertical faces at points not less than one-quarter of the depth from the edge of the piece.

Only 9 stringers of the 175 tested met this specification. As in the specification just preceding, the fact that no knots at all were permitted within a certain specified distance of the edges was the reason for rejecting most of the material. The rate-of-growth specifivation was also the cause of throwing out some material which passed the knot specification.

The average fiber stress at elastic limit, modulus of rupture, and modulus of elasticity of the stringers passing this specification were, respectively, 4,835, 7,062, 1,767,000, lbs. per sq. in. The maximum values were, respectively, 5,540, 7,930, and 1,970,000; the minimum 4,300, 5,320 and 1,565,000.

SPECIFICATION D.—These grading rules contain very few specific statements regarding the character of the different defects which will be permitted, but like Specification A they leave a great deal to the judgment of the inspector.

All of the material tested was graded according to these rules by one of the inspectors of the lumber manufacturers' associations cooperating in the work.

SPECIFICATION E.—This was first compiled by Committee "Q" of the American Society for Testing Materials and with minor modifications was adopted by the American Railway Engineer-

ing and Maintenance of Way Association as its standard specification for bridge and trestle timbers. The specification as printed is the form adopted by the American Railway Engineering and Maintenance of Way Association.

The specification defines only two grades but in this analysis of the test data, the stringers which failed to make either of these grades have been classified as culls.

Table IV gives the summarized results of the strength values of the timbers tested, graded according to Specifications D and E.

Specifications D and E are evidently the most practical of those quoted. To further compare their efficiency in grouping material according to its mechanical properties, the results of the tests are shown graphically in the diagram in Fig. 2. For each grade indicated in the diagram, the modulus of rupture and modulus of elasticity are shown to the right of the heavy vertical line and to the left of the line the fiber stress at elastic limit is plotted. The vertical scale is in pounds per square inch except that part of it which indicates the modulus of elasticity which should be read in 1,000 lbs. per sq. in. The length of the shaded portions between the horizontal lines is proportional to the total number of tests falling within the limits indicated on the vertical scale. The points within the shaded areas show the grouping of the individual tests.

A study of the diagram brings out the following points:

1. That according to Specification D the 175 stringers tested were made up of 59 selects, 75 merchantables, and 37 seconds; according to Specification E, they were made up of 54 R. R. No. 1, 66 R. R. No. 2, and 54 culls.

2. Specification E succeeds in eliminating from the highest grade, material having a modulus of rupture less than 6,000 lbs. per sq. in. with the exception of one stick which developed a modulus of rupture of approximately 4,200 lbs. per sq. in. This exception makes the extreme range in strength of the grades R. R. No. 1 and selects the same.

3. The grade R. R. No. 2, with four exceptions, rules out material having a modulus of rupture of less than 5,000 lbs. per sq. in., the extreme range in the modulus of rupture being from 4,200 lbs. per sq. in. to 7,800 lbs. per sq. in. The merchantable grade admits 14 sticks having a modulus of rupture less than 5,000 lbs. per sq. in. and shows an extreme range in the modulus of rupture of from 3,500 to 8,800 lbs. per sq. in.

4. The extreme range in the seconds is from 3,000 lbs. per sq. in. to 8,300 lbs. per sq. in., while the culls of Specification E range in strength from 3,000 lbs. per sq. in. to 7,600 lbs. per sq. in.

5. It will be noticed that 40 of the culls, or 74% of the timbers excluded from the grades R. R. No. 1 and R. R. No. 2, were stronger than the weakest timbers of the grade R. R. No. 2. Thirty-one seconds, or 84% of the seconds, were stronger than the weakest timbers in the merchantable grade.

6. The effectiveness of the specifications in grading material according to its fiber stress at elastic limit and its modulus of elasticity is also shown in the diagram. Specification E apparently is effective in culling material having a fiber stress at elastic limit of less than 3,000 lbs. per sq. in. Approximately 60% of the material culled, however, had a fiber stress at elastic limit greater than this.

The value of a specification or grading rule depends largely upon its reliability in excluding material which is deemed undesirable and in admitting material adapted to the needs of the purchaser.

The range in the properties of the different grades considered in Fig. 2, indicates that Specification E is somewhat more reliable in grouping material according to the merchantable properties than Specification D. On the other hand, more material having the required properties is culled by Specification E than by Specification D; 40 sticks as good as those admitted to R. R. No. 2 are thrown into the lowest grade in order to exclude the 14 sticks falling below the minimum strength shown in the R. R. No. 2. In Specification D, 30 timbers as good as those included in the merchantable grade are thrown into the lowest grade in order to exclude the 5 pieces falling below the minimum strength shown in the merchantable grade.

So many factors, which cannot be detected by a visual inspection, influence the properties of structural timbers that the question of formulating grading rules which can be relied upon to exclude material falling below a specified strength is one extremely doubtful of solution. The one timber having a modulus of rupture of approximately 4,000 lbs. to the square inch which passed the specification for R. R. No. 1 makes it unsafe to rely upon greater strength in timbers of this grade than in timbers of the next lower grade. The practicability, therefore, of having more than one grade for Douglas fir in structural sizes seems questionable.

Various attempts were made to introduce other factors, such as summerwood and rate of growth, with the idea of modifying Specification E so that fewer sticks having a modulus of rupture greater than 4,000 lbs. per sq. in. would be excluded, but none of the attempts were attended with much success. This specification seems to be as practical and effective as any that have been devised for grading Douglas fir. The results of the tests show, however, that much of the material falling in the two lowest grades (seconds and culls) has considerable structural merit and could be safely and economically used in falsework and structures of a temporary character.

TABLE IV.—RESULTS OF BENDING TESTS ON GREEN MATERIAL WITH DEFECTS, GRADED BY SPECIFICATIONS D AND E.

[Test Pieces 5 × 8 ins. × 15 ft.]

	Bending. Extreme fiber stress at elast. lim. Lbs. per sq. in.		Modulus of rupture. Lbs. per sq. in.		Modulus of elasticity. 1,000 lbs. per sq. in.	
	D	E	D	E	D	E
Selects or R. R. I.:						
High 10%.	5,280	5,800	7,497	8,468	2,167	1,964
Low 10%.	3,187	3,374	4,827	5,750	1,262	1,303
Average .	4,320	4,516	6,147	7,108	1,698	1,678
Merchantable or R. R. II.:						
High 10%.	4,597	5,006	6,353	7,430	1,848	1,875
Low 10%.	2,580	3,109	3,710	4,761	1,221	1,239
Average .	3,532	4,057	4,946	6,116	1,513	1,528
Seconds or culls:						
High 10%.	4,790	4,656	6,457	6,700	1,848	1,715
Low 10%.	2,177	2,292	3,100	3,232	1,125	915
Average .	3,344	3,330	4,618	4,845	1,419	1,310

Annual Convention of the Central States Water-Works Association.

Younger by far than either the American or the New England water-works associations the organization representing the nine states of Pennsylvania, West Virginia, Kentucky, Ohio, Indiana, Illinois, Michigan, Wisconsin and Missouri, is sufficiently old to hold its fifteenth annual meeting. This occurred at Cleveland, O., Sept. 19 to 21.

The attendance was about fifty, including supply men. The number of papers was small, but they were well received and elicited discussion. Besides the two or three formal sessions the delegates visited the Kirtland St. pumping station and the lake-intake crib of the Cleveland waterworks and the plant of the Glauber Brass Manufacturing Co.

Detroit was chosen as the meeting place for 1912. The principal officers chosen for the ensuing year were: President, W. J. Scroggins, Superintendent of Water-Works, Wheeling, W. Va.; Vice-President, Wm. Allen Veach, Newark, O.; Secretary, R. P. Bricker, Shelby, O.

In welcoming the association, at the opening session, Mr. Leslie C. Smith, Superintendent of Water-Works, Cleveland, O., urged that efficient service and justice to all should be the dominant characteristics of water-works management, whether under public or private ownership. Mr. Smith outlined the history and main features of the water-works of Cleveland, and called attention to its very low meter rate of 5⅓ cts. per 1,000 gals. "to the ordinary consumer." A welcome to Cleveland was also extended by Mr. E. P. Roberts, President of the Cleveland Engineering Society.

SMOKE PREVENTION IN CLEVELAND.—In the course of his remarks Mr. Roberts gave an account of the work of the Smoke Prevention Committee of the Cleveland Chamber of Commerce, of which committee he had been chairman for three years. As a result of a house-to-house canvass for the purpose of collecting data it has been estimated that property losses in Cleveland, due to smoke damage to shelf goods and house furnishings, not to include defacement of architectural exteriors, costs the citizens an average of $12 per year per capita. Mr. Roberts advocated paying firemen and engineers higher salaries whenever they effect large savings in coal consumption.

PRESIDENT'S ADDRESS.—This was delivered by the incumbent for the past year, Mr. Alba L. Homes, Grand Rapids, Mich. The speaker urged that each city should base its rates upon the cost of the water sold by it, instead of copying the rates of other cities; and that in so doing the cost of the service be equitably distributed among the consumers. Allowances for depreciation and a uniform system of accounting were also urged.

Attention was called to the editorial note published in this journal on Sept. 14, 1911, dealing with the inspection of water fixtures and closing with a characterization of the water meter as the best possible inspector. After quoting a large part of the note Mr. Holmes said:

> This extract from Engineering News hits the nail on the head and settles the question of waste in the only way that it can be settled. Commencing at the pumping station, or distributing reservoir, meter all the output. Meter every tap, except fire hydrants. Make the rate for water high enough so that users cannot afford to have leaky fixtures, and have a charge for "ready to serve" on all fixtures, taking cognizance of their size. Allow no so-called "fire lines" of large size to be run into private grounds without meters thereon, and allow no dictation of fire insurance companies as to how your department shall be run.

At another point in his address Mr. Holmes commended the supervision of the rates and service of both public and private water-works plants by state commissions, as is done by the Wisconsin Railroad Commission. Such regulation, the speaker urged, is desirable in every state. This portion of the speaker's remarks was concluded as follows:

> Various matters of this kind are in a chaotic state in our plants; and if we had a state regulation along these lines it would improve the working of the departments and avoid the local political and personal (machinations?) that seek to steer the only department of the municipality that sells its product along the lines of inefficiency and graft. The agitation that must take place, the initiation of which must come from the water-works man, should be started and pressed in the various water-works associations of the country, to the end that uniformity of results may be obtained in each state, as nearly as conditions will permit, and in this work I feel that we shall receive the support and aid of the different boards of health of the states in which we reside.

STREAM POLLUTION IN OHIO.—The first paper presented bore the foregoing title and was sent in by Mr. John W. Hill, member of the Ohio State Board of Health, of Cincinnati. The author said at the outset that although the pollution of a stream by sewage may lead to epidemics of typhoid and cholera he could recall no typhoid epidemic due to "sewage-polluted inland waters" of the state, while of course no cholera outbreak in Ohio had been due to that course. What may be termed a rational view of sewage disposal by dilution was upheld by the author.

The large power over stream pollution given to the Ohio State Board of Health by the Bense act of 1908 has been declared non-effective by the Darke County Circuit Court. The legality of the act is now before the State Supreme Court. This act gave the Board power to require cities and villages to establish sewage purification works, but was limited to sewerage systems discharging into streams wholly within the state. This limitation was declared discriminatory and thus the act was held to be illegal.

Evidently the author of the paper thinks that water pollution by manufacturing wastes is not receiving sufficient attention in Ohio. He wrote:

> The objection to stream pollution as practiced here, is not based so much on the sanitary sewage from built-up communities, as it is to the use of streams for the disposal of manufacturing wastes and the use of the banks of the streams as dumps for city and village offal. The manufacturing wastes containing acids, alkalies, and dye liquors, offend the esthetic sense and have more to do with the creation of nuisances and destruction of fish life in our streams than the sewage from the cities, and curiously enough as I understand the statutes governing the State Board of Health, they do not give to the Board the power to reach the manufacturing establishments which are now polluting the streams excepting where the wastes are merged into city sewage, and where the sewage of the city is dealt with by the Board.

Mr. Hill's paper gave rise to considerable discussion as to the relative parts in the spread of typhoid fever played by water and milk. Mr. C. W. Wiles, Delaware, O., maintained that many outbreaks attributed to public water-supplies

were really due to infected milk. President Holmes believed that more than half the cases laid to water were due to other causes. Mr. Fred B. Leopold, of Pittsburgh, Pa., combated what he thought to be a tendency on the part of the other speakers to minimize the dangers from polluted water and the importance of filtration.

Imhoff tanks for treating the sewage of a suburban district in Baltimore County, Md., Mr. Leopold said, are being built by private interests, within a few hundred feet of residences already constructed in what is expected to be the best residence section of the district.

UNIFORM WATER RATES.—Mr. C. W. Wiles, of Delaware, O., submitted arguments aimed against the popular fallacy that water rates may be uniform from city to city. Obviously this is impracticable since the cost of supplying water in no two cities is the same. Mr. Niles also argued against uniform meter rates for all consumers in a given city, advancing the familiar wholesale and retail cost-of-service theory. By way of illustration he gave the following example:

> If one consumer uses 2,000,000 gals. per month it requires no more time and expense to read his meter, make his bill and collect it, then it does a consumer who uses 2,000 gals.; therefore there is 99 times more labor and bookkeeping required to care for 100 small consumers whose average is 2,000 gals. per month than one who uses 2,000,000 gals.; and as a business proposition he is entitled to a better rate. Assuming that it is worth 50 cts. each to read the meters, make the bills, enter them on the books, and make the collections, then the cost for the 100 will be $50 as against 50 cts. for the large consumer.*

Considerable discussion was elicited by Mr. Wile's paper, most of which was in agreement with his main contention that water rates should not be uniform, either between cities or between large and small consumers in the same city. Stress was laid upon the varying percentages of domestic and manufacturing consumption in different cities and their effect upon water rates; also upon the greater value of pure than of impure water. On the latter subject, Mr. Vernon stated that after spending $200,000 for water purification and softening at McKeesport, Pa., it became necessary to increase the water rates, but that this was more than offset by the decrease in soap and plumbing bills. The washing soda sales of one jobber alone fell from $30,000 to $5,000 a year, and the number of journeymen plumbers has materially decreased.

As to lower rates for large than for small consumers, Mr. Niles and others stated that without this difference large consumers would establish their own water-supplies.

ELECTRIC-DRIVEN PUMPS.—A paper entitled "Electric Drive for Water-Works in Rural Districts," written by Mr. W. H. Smith, was read by Mr. R. L. Rathbone (both connected with the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.). The paper gave rise to an extended discussion on the general subject of electric as compared with steam or gas-driven pumps, backed by examples and figures favorable to electric pumping. The value of the discussion might have been increased had the author of the paper been present to answer a number of questions raised by those present [perhaps the author will contribute a written discussion, reviewing the questions and the positive remarks of the various speakers, but this is unusual with the minor technical associations.—Ed.]. Among places mentioned as using electrically-driven pumps for part or all of their supplies were Pittsburgh and Monongahela, Pa., and Dennison and Toronto, O. Several speakers, including Westinghouse representatives present, emphasized the importance of taking all local conditions into account in estimating the relative advantages of electric and other power.

ARE WATER METERS ADVANTAGEOUS OR OTHERWISE?—A paper with this title, by Mr. George Houston, one of the water commissioners of Kalamazoo, Mich., set forth the benefits derived from meters in that city (see abstract, elsewhere in this issue). Like all papers on meters, this one gave rise to free discussion; and, as is generally the case where water-works men are assembled, the discussion was favorable to meters. Mr. Beardsley told how meters at Cleveland had reduced the consumption from 172 gals. per capita in 1901 to 98 gals. in 1909. While the 1910 average was 102, the revenue for that year was $1,062,588, against $958,608 in 1909. The increased pumpage, Mr. Roberts interjected, was due to the dry weather of 1910, but Mr. Beardsley remarked that it was all paid for.

The chronic sore spot among water-works men, charges for private fire-protection lines, was touched by a number of speakers, all or nearly all of whom believed that this class of supply should be paid for, while one speaker suggested that the charge include a "ready-to-serve" allowance. President Holmes referred to the dictatorial attitude of the fire insurance interests, which demand that all factories be provided with fire protection, whether it is paid for or not. He said that the large cities may be able to guard their rights in this particular, but some of the smaller cities and private water companies cannot do so, and should be given protection.

OTHER DOINGS.—Mr. F. B. Leopold, Pittsburgh, Pa., presented data on the cost of operating mechanical and slow sand filtration plants.

Standing committees were provided for, as follows: Pumping Engines, Uniform Accounts for Plants of Average Size, Fuel Consumption and Boiler Economy; Depreciation; Water Meters; Fire Lines and Sprinkler Services.

*[Those interested in a scientific plan for water rates, designed to distribute the cost of service equitably, may consult the paper on "Water Rates," by Mr. George G. Earl, of New Orleans, read before the American Water Works Association in June, 1911, and published in Engineering News for July 20, 1911.—Ed.]

An International Competition in Planning the New Capital City at Australia.

The Government of the Commonwealth of Australia has finally completed all the preliminary studies incident to the founding of a new federal capital, as provided in the Constitution signed July, 1900, and has announced a competition for the design of the capital city. This competition is open to citizens of all countries, and full information for the guidance of intending competitors is available at the British Embassies of the leading powers of the world. Designs must be anonymously submitted to the Department of Home Affairs at Melbourne before Jan. 31, 1912, and will then be passed on by an official commission. The three designs judged most acceptable are to receive £1,750, £750 and £500, in the order of merit respectively. They then become the property of the Commonwealth to be used as may be seen fit.

Wide choice in the nature of the plans to be submitted is allowed by the terms of the competition, which merely calls for "designs for laying out the Capital city" with the additional recommendation that "it is desirable that at least outlines of the more important public and other buildings, parks, gardens, bridges and principal constructional features be indicated, in so far as they illustrate the General Design." There are available full topographical and geological maps, together with panoramic views of the site, a climactic record and a book of information which sets forth in much detail the requirements for the city. The problem before the competitors is the laying out in the open country of a monumental city capable in the beginning of housing the government of a nation and 25,000 inhabitants and elastic enough in design to allow for ample future growth.

The present Commonwealth of Australia was formed in 1900 by the combination of the various separate British colonies of the island continent, and one of the sections of the Constitution adopted provided for the establishment of a new seat of government "in the state of New South Wales, distant not less than 100 miles from Sydney." Provision was also made that the territory should be vested in the Commonwealth and be not less than 100 sq. miles in area. After much consideration Parliament in 1908 framed an act locating the new federal district in the district of Yass-Canberra, N. S. W. Official surveys were then started as a result of which on Jan. 1, 1911, the Commonwealth took over the jurisdiction of the new territory, and having established the location for the capital city (not yet named) in that territory, started work on the plans for the present competition.

The new district contains about 900 sq. miles, the center of which is located in the mountains about 170 miles southwest of Sydney, about 70 miles west of the eastern coast line of Australia, and about 300 miles northeast from Melbourne. The site selected for the city is in the northern part of the territory (Lat. 35° 15' South, 149° 15' East of Greenwich), an area 10 miles square, situated at an average elevation of 3,000 ft. above sea level and divided into two parts by the Molonglo River, a sluggish stream, from 300 to 500 ft. wide, draining some 700 sq. miles of upland country. Ordinarily this river is unnavigable and sometimes dry, but in the rainy season it is subject to occasional floods which must be considered in the design of the city.

The location is the most pleasing in general topographical features and in climate that could be found in the territory prescribed by the Constitution. The maximum shade temperature recorded is 104° F., but this is unusual; the minimum is 11°. The average expected temperature at the site of the city is given as follows: The mean of the three hottest months is 67.5°; the mean of the three coldest months 41.8°; the average hottest month 68.4°; the average coldest month, 39.7°. The temperature but infrequently falls below freezing and it is rare for snow to fall and it is more rare for it to remain unthawed for more than a few hours after sunrise. The average annual rainfall in the district during the records available is 22.6 ins., with a maximum of 41.3 and a minimum of 10.4. It is stated that the soil and the climate are very favorable to vegetable growth, so that there is great opportunity for arboriculture both in the streets and in the public parks. Difficulty will be found in providing building material for the city, as building stone is not available in any extent within less than 100 miles of the city's site. Bricks of good quality can be made locally and there is everywhere ample material for broken stone.

The advertisement for the competition states that as the city will be the official and social center of Australia every effort should be made to design a city plan which will be worthy of the great state which the city represents. Special consideration should be given to the location of areas suitably situated for the government buildings and courts, churches, art gallery, library, university, city buildings, railway stations, military barracks, hospitals, national theater, markets, stadium and parks and gardens. In addition to these, areas must be laid out for commercial, residential and industrial purposes. At present no railway enters the city area, but the proposed route is given on the maps which accompany the competition and due regard must be taken in the design for the proper disposition of this railway within the city limits. It is proposed that the Molonglo River be dammed in the vicinity of the city in order to control the flood waters and to maintain ornamental water sites near the town. Water-supply is to be provided on the basis of 100 gals. per capita per diem, and it has been found in the surveys that there is available a sufficient amount of water which can be delivered by gravitation to a service reservoir outside the city limits. Sewage will be water-carried by gravitation and delivered to treatment works some six miles away from the city, while storm water is to be emptied into the river. All of these systems should be indicated, at least, in the design.

Finally it is evident from the documents which have been issued that it is the intention to provide for the Government of Australia as sightly and as modern a city as is possible in the present stage of the art. The Government recommends to the competitors a study of all the recent developments in city planning and expresses the hope that the designs submitted will not only allow the construction of the finest city in the world to-day but will so anticipate future needs as to be a basis for development through some centuries to come.

A Steam-Shovel Attachment for Derricks.

A promising novelty in excavating machinery has been recently developed in the form of an attachment for temporarily converting a derrick into a steam shovel, or a derrick boat into a dipper dredge. A dipper and handle of the type used on a steam shovel is attached to the derrick boom by means of a sliding carriage. With the dipper arm in the digging position, a cam at its end locks the carriage stationary on the derrick boom. But when the dipper arm is raised toward the dumping position, the carriage is released automatically so that the dipper can travel out along the derrick boom to the end before dumping. The carriage can be locked to the derrick boom at any point, so that digging can be done over a considerable area without moving the derrick.

Fig. 1. Digging Position.

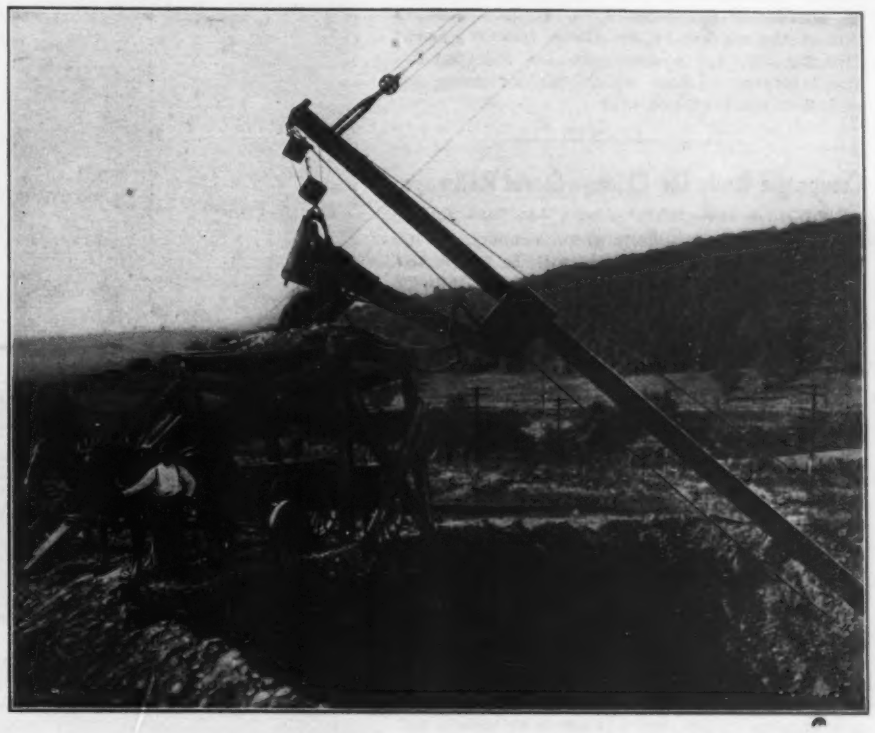


Fig. 2. Dumping at Top of Bank.

FIGS. 1 AND 2. THE BISHOP STEAM-SHOVEL ATTACHMENT APPLIED TO A GUY DERRICK.

Fig. 3. The Derrick Steam Shovel, Showing the Sliding Carriage.

The attachment is shown in the digging position in Fig. 1. An examination of the photograph gives an idea of the possibilities of the device in working over a considerable area. We are informed, too, that digging can be done satisfactorily below the level of the derrick base, to a depth limited by the length of the dipper arm.

The dipper is handled by means of both the hoisting and boom-haul lines. The hoisting line is attached to the bale of the dipper and pulls it into its cut. By slacking away on the boom haul, the weight of the derrick boom is brought into play to hold the dipper down to its work in hard material. The dipper arm is raised by means of the hoist line when the dipper is full to enable it to clear the bank. If necessary the derrick boom is also raised a little. In the raised position, the dipper arm automatically releases its carriage lock, and by further pulling in on the hoist line the shovel is slid out toward the end of the derrick boom, where it is dumped, as shown in Fig. 2. In the case of the pit shown in this photograph, it is claimed that the greater convenience of loading at the top of the bank enabled one team to do the work which required three teams when loading was done in the pit by an ordinary steam shovel.

The shovel can be handled, as just explained, with an ordinary two-drum derrick engine and the device can be used on any derrick that could manage a 1-yd. scraper bucket. On larger derricks, where it would be impracticable to raise and lower the derrick boom for each shovelful, a third line is required to pull back the dipper arm. This makes necessary a three-drum engine. The sliding carriage, in such a case, could be returned from the boom end by a counter balance.

The dumping is accomplished by means of a stop iron attached to the carriage, which acts on a bell-crank connected by a cord or chain to the bolt of the drop-bottom. As the two sheaves of the hoist line approach each other near the end of the boom, the shovel-end of the dipper arm is brought closer to the boom, and at a predetermined point the dipper arm is high enough to bring the bell-crank against the dumping iron. This is clearly shown in Fig. 2. The bell-crank is seen attached to the back of the dipper boom and had just come in contact with the hook-shaped dumping iron when the photograph was taken. After the dipper is dumped, the operator slacks gently on the hoist line until the carriage has returned to the desired position and then releases it altogether, so that the dipper boom swings back to the digging position and locks the carriage.

A closer view of the shovel, Fig. 3, shows the construction of the carriage and the method of attaching it to the boom. It consists of two side plates separated by a channel deep enough to allow the boom to pass between them. The line of bolts holding the channel flange to the nearer side plate can be seen in Fig. 3 just below the boom. Above the channel are four rollers, two above and two below the boom, mounted on bolts passing through the side plates. The dipper arm is hung on a pin at the lower end of the carriage.

The carriage is not locked to the boom itself but to a wire cable fastened securely to each end of the boom and used solely for this purpose. The cable can be seen in the photographs passing through the carriage below the boom. The construction of the locking device is shown somewhat diagrammatically in Fig. 4. The cable passes between two flat plates hung on bolts from the channel connecting the side plates. These plates are held apart by springs in the released position, but are pressed together

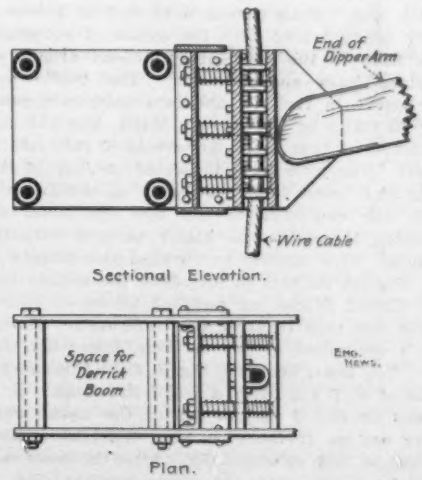


Fig. 4. Diagrammatic Detail of Carriage, Showing The Clamping Device.

so as to grip the cable by the cam-shaped end of the dipper arm. The grip is made positive by a system of U-shaped rods encircling the cable and pressed against its lower side alternating with transverse rods on the upper side. The arms of the U-rods slide through holes in the upper clamp plate. This plate is held away from the channel by a separate set of stout helical springs, which prevents the crushing of the cable. This device is the invention of Mr. Storrs M. Bishop. of Schenectady, N. Y., and is being put on the market by the Union Iron Works, of Hoboken, N. J., to whom we are indebted for the information from which the foregoing description has been prepared.

Composite Rails for Chicago Street Railways.

By WM. A. DEL MAR,* Assoc. Am. Inst. E. E.

Railway men, especially those connected with maintenance-of-way matters, will be interested in the announcements of the Chicago Railway Co. and the Chicago City Railway Co., that they have each ordered composite rails to the extent of two miles of track, the order having been placed with the Carnegie Steel Co.

While composite rails of divers kinds have been put on the market from time to time, they have met with little or no success until quite recently, when a new type was invented which dispenses with screws, bolts or separate fastenings of any kind. An installation of this type was laid at Leeds, England, in 1906, where its unqualified success attracted the attention of French engineers, two of whom decided to give it a trial in Paris.

At Leeds a stretch of double track was laid in Kirkstall Road, one of the busiest parts of that city and no repairs have been necessary up to date. The rail laid there weighs 121 lbs. to the yard and has carried 1,350,000 axles, each bearing 12,300 lbs., unloaded, at speeds up to 18 miles per hour. The local trucking is also exceptionally heavy. Not only have no repairs been necessary, but the composite rail is absolutely free from corrugations, although other rails in different portions of the track, (some of which have been laid since 1906) have become badly corrugated.

On Aug. 16, 1910, the Compagnie Generale des Omnibus, laid these rails on a curve of 25 meters radius at the corner of the Rue du Louvre and the Quai du Louvre, and on Aug. 29, the Compagnie du Metropolitain placed the rails on a curve of 50 meters radius in the Gambetta loop. Both curves were laid at points of very heavy traffic with the object of subjecting the rails to the severest conditions arising on surface lines and subways. The traffic over the curve in the Metropolitain subway consists of 300 trains of 6 cars each, daily, and the construction is that of an uncovered T rail, laid as usual. The rails were inspected in July of this year and were found to be in splendid condition, the engineers of the two companies expressing themselves as highly pleased with the results. This success encouraged the holders of the English patents to introduce the system into the United States, as recorded above.

The new rails (bearing the trade name "Romapac") are rolled in two sections, lower and upper. The lower sections, Fig. 1, have the appearance of a T rail with a small flat head. It is spiked or bolted to the ties in the usual way; there are no surfaces to wear and the section should be laid substantially. After the lower sections have been laid, the upper sections, Fig. 2, which have depending sides, are superimposed in such a way as to break joints with them, as shown in Fig. 3. The sides of the upper section are then pressed or crimped by a machine so that they grip the head of the low sections along their entire length and produce a complete and continuous rail. It is obvious that the upper sections may be shaped to form, with the lower sections, "T," trilby or girder rails.

The staggered joints of the composite rail make a smooth track which has been found to reduce the wear of rails and rolling stock. It is also to be expected that some small saving of power will result. With this composite rail, all fastenings are dispensed with; no fish-plates, bolts, angle-bars, or sole-plates are required. It is therefore possible economically to use rails of shorter length than 60 feet, and the web of the rail can be made lighter than usual, owing to the absence of end holes. The composite rails also form a continuous electrical conductor so that no electrical bonding is necessary and damage from electrolysis so far as due to faulty bonding, is eliminated. Tests made at Leeds show that the resistance of a given length of rail is only what would be expected if the rail were truly continuous—without joints of any sort.

The saving effected in the cost of joints and bonds varies, of course, with the weight and length of the rail used and with the cost of labor and materials where the track is laid. A fair estimate of the saving under average American conditions, would be about $1,000 per mile of single track.

When the upper section of the composite rail is worn out, a machine cuts it off and then crimps on a new top, saving about half the weight of metal used in renewals and in the case of uncovered "T" rails, making other disturbance of the permanent way unnecesary. Where the rails are laid in streets and are covered to the level of the pavement, only 6 to 8 in. of pavement on each side of the rails need be disturbed when they are renewed, and as much saving as $4,000 to $5,000 is claimed for each renewal of a mile of such single track.

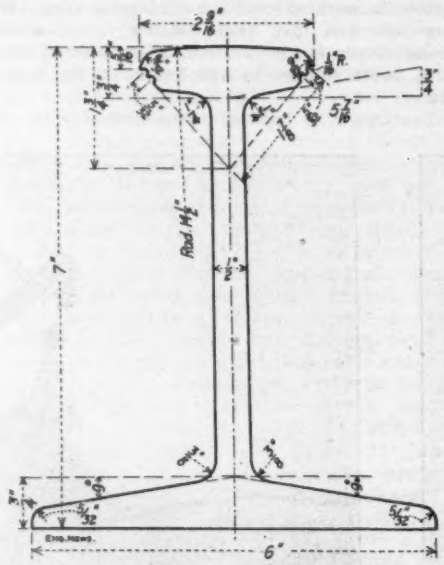


Fig. 1. Lower Section.

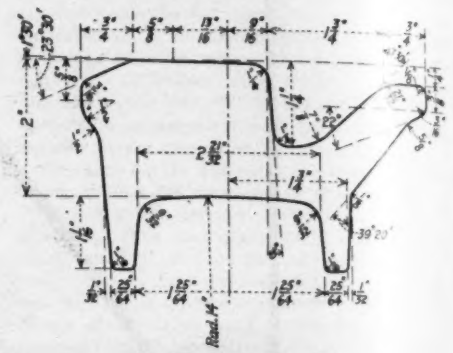


Fig. 2. Upper Section.

FIGS. I AND 2. A NEW DESIGN OF CONTINUOUS COMPOSITE RAIL.
(Continuous Rail Co., New York City.)

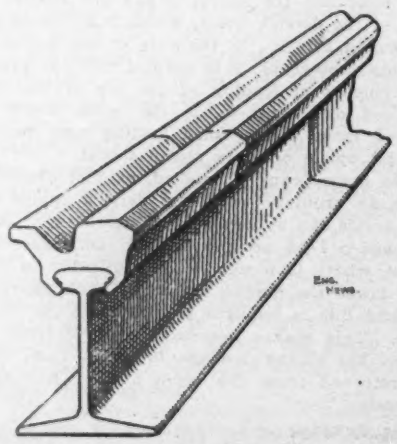


Fig. 3. The "Romapac" Rail Assembled, Showing Staggered Section Joints.

One machine can crimp 780 ft. of rail per hour and the cost of running the machine is less than 56 cts. per hr. The cutting off is done at the same speed and cost. A half mile of track has been laid in ten hours.

The machine has fastened and removed upper sections made of "Imperial" manganese steel, cast by Messrs. Edgar Allen and Co. of Sheffield. This opens up a new development in track construction which may have important consequences, especially for subways and elevated railways.

The American rights for the new rail are held by the Continuous Rail Co., 17 Battery Place, New York City.

Measurements of Heat Produced in Metal Cutting, reported by Prof. N. N. Sawwin, of the St. Petersburg Polytechnic Institute, in the "Zeitschrift des Oesterreichischen Ingenieur & Architekten Vereines," show some surprising results. The amount of heat generated was usually more, but in a few instances less, than it should be, according to the true mechanical equivalent of heat. For unannealed machinery steel, cut with a tool of high-speed steel, values ranging from 345 to 407 kg-m. per kg.-calorie were found, the lower values being obtained with a feed of 0.4 mm., the higher ones with feed of 0.2 mm. Cutting mild steel (0.21% C.), again with high-speed steel, the values ranged from 375 to 425, and here also the higher feeds gave the lowest results while the lowest feeds gave the highest results. The same mild steel after annealing gave more regular results, the average values being 410 to 429. In cutting cast-iron, the values were regular (416 to 422) except for the largest feed (0.6 mm.), where the value 394 was obtained. Brass showed the singular characteristic of values higher than the true equivalent, giving 446 to 461 in five runs; this indicated the disappearance of heat in the cutting process. Copper gave normal values, 400 to 434, the variations having no relation to feed.

The author concludes that internal strains in unannealed steel, which strains are released in cutting, are responsible for giving a heat-output greater than chargeable to the work of cutting (i. e. low value of mechanical work per calorie); while in brass the deficiency of heat-output (i. e. high value of work per calorie) is to be expained probably by alteration of the chemical alloy constituents. He concludes also that for engineering calculations it is sufficient in all cases to figure heat production from the true mechanical equivalent of heat (427 kg.-m. per kg.-calorie).

Lignite as a Fuel for Gas Producers is quite extensively in use in Texas according to Bulletin No. 159 of the University of Texas, dated July 1, 1911. Of the 47 producer-gas plants now in active operation in that state, 23 use Texas lignite exclusively. Most of these installations are of comparatively small size, but there are two plants which comprise together 7,700 HP. This is 67% of the total horse-power (11,490 HP.) of all the lignite producer plants. The total lignite consumption at these plants is about 180 tons per day of 24 hours. The gas made is used both for fuel in lime kilns, etc., and for power production in specially designed gas engines. The cost of the lignite, delivered, varies from 90 cents to $3.45 per ton, depending on the distance from the mines and the amount involved in the contract. The lignite production of Texas in 1910 was 979,232 tons with an average value of 96 cents per ton at the mines.

*355 Madison Ave., (Room 1241) New York City.

An Aerial Cableway for Handling Coal From Mine to Colliery.

By B. BENTHAUS, M. I. M. E.*

An aerial cableway, 6,234 ft. long, for transporting loaded mine cars from the mines to the breaker, has been installed at the Witkowitz Collieries in Germany. The system is known as the "Heckel System," and is manufactured by the Haulage Plant Co., Ltd., of Saarbruecken. The special feature of the system is the simple way in which the cars are attached to the carriers, dispensing with the usual laborious method of discharging from cars into bunkers, and from bunkers to aerial buckets, and with the previous method here used of chaining the cars to the carriers.

This feature is clearly shown by Fig. 1. The cars are carried on a steel platform supsended from the frame of the carrier, on which the cars are run and held in place by a movable bar dropped over the end of the car. Transferring the cars from and to the platform is facilitated by a special automatic stopping device which halts the cars directly opposite the rails of discharging and entering tracks.

This arrangement has many advantages over the method formerly employed of attaching the cars to the carriers by chains. It makes it unnecessary to build the cars as strongly as was previously done, and it eliminates the rings, pivots or hooks, which, when the great number of cars used is considered, means a considerable saving. Variations in the sizes and shapes of cars do not form obstacles for their transport, the only requirement being that the gage of the trucks remains the same. Much time over the older methods is saved in securing and releasing the cars.

Each car has a capacity for about 1,760 lbs. of coal, or 2,400 lbs. of heavier waste material. Including the weight of the car, this makes the total net load on the carrier, not including the weight of the carrier itself, between 2,400 and 3,300 lbs. To carry such a heavy load the special four-wheel carrier, shown in Fig. 1, was designed. The wheels are much larger than the usual construction and have extra wide grooves. The four wheels are not connected to a rigid frame, but are divided into pairs, each pair being connected by a separate hanger to a balancing beam, from the center of which the carrier frame is suspended. This arrangement distributes the load over a greater length of cable and at the same time enables the carrier to better follow the deflections of the cable, and prevents the lifting of the wheels from the rope, and hence the danger of their running off the cable.

The aerial construction is clearly shown by Fig. 2. The towers are of steel angles on concrete bases. A specially-designed rod bracket guide is provided to catch the haulage rope after the passage of a carrier. In passing over the colliery yards heavy brackets are added to the towers from which is suspended a wire net to protect those below from falling fragments. The crossing over a railway track is protected by a solid-floor bridge, as it is also a crossing over a highway. The carriers travel at the rate of 6.6 ft. per sec. and follow each other at intervals of 131 ft., giving the cableway a capacity of 180 cars per hour.

Fig. 1. Heckel System Cableway; Carrier for Handling Mine Cars.
[Installed at the Witkowitz Collieries, Germany.]

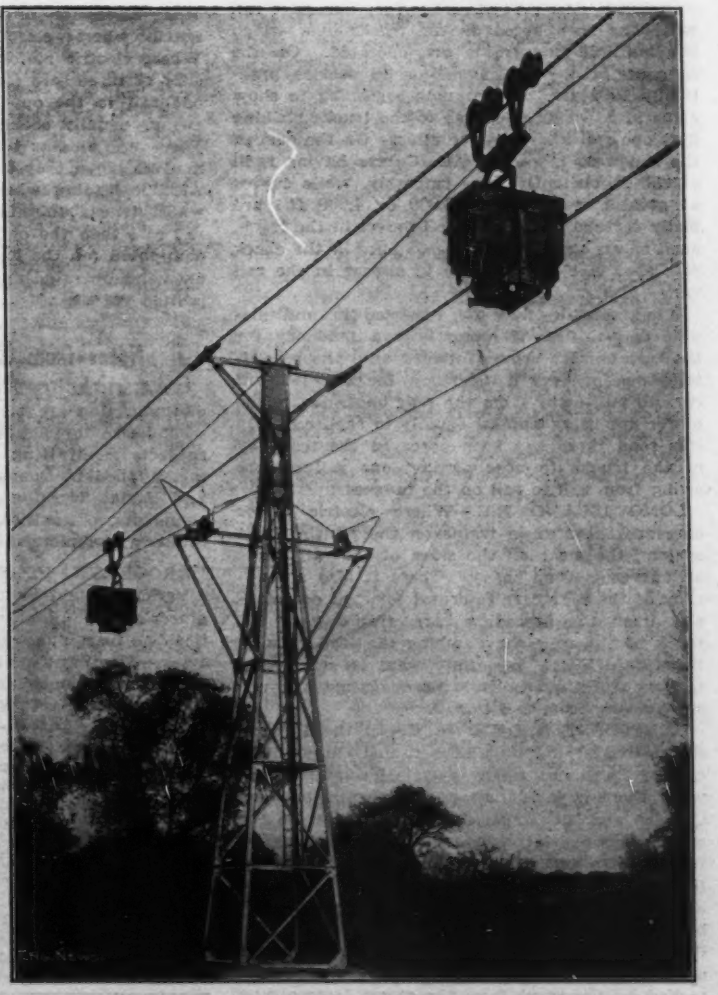


FIG. 2. TOWER CONSTRUCTION OF THE HECKEL CABLEWAY SYSTEM, SAARBRUECKEN, GERMANY.

*Consulting Mechanical Engineer and Contractor, 45 Bank St., Sheffield, England.

What Water Meters Have Accomplished at Kalamazoo, Mich.

An interesting and instructive water-meter story was told by Mr. George Houston, Water Commissioner of Kalamazoo, Mich., at the convention of the Central States Water-Works Association, held at Cleveland, Ohio, Sept. 20 and 21, 1911.

The gist of the story was that the total yearly water consumption of Kalamazoo was less in 1910-11 than in 1892-3, the per capita consumption some 60% less, and the revenue 150% greater, although meanwhile the rates had been lowered. All this followed the introduction of meters and was accompanied by an unusual incident relating to a sewer, and an all-too common experience with a private fire-protection supply. Another point of special interest is Mr. Houston's belief in placing the burden of providing water meters on the water consumer, instead of on the city. These and other interesting features of the paper are brought out in the following abstract:

The water pumpage of Kalamazoo averaged 2,157,000 gals. per day or about 110 per capita for the year ending March 31, 1893. (Population in 1890, nearly 18,000). An increase in the source of supply or a reduction of waste was imperative. An appropriation of $4,000 was provided for the purchase of meters and perhaps a hundred were placed on large consumers during the ensuing year.

Up to 1898, when Mr. Houston took charge of the water-works office, only 375 meters had been placed, and thereafter a more vigorous metering policy was pursued, but not for some years afterwards were all the taps metered.

About this time the city appropriated $7,000 to replace the Vine St. sewer with a larger one, because of overflows at a manhole every winter. The water authorities maintained that the waste was due to water let run to waste to save freezing of the house water pipes, and "after an earnest and hard fight" succeeded in getting the city council to cut the sewer appropriation from the budget and to order all sewered houses metered. Since this measure was carried out the population of the district tributary to the Vine St. sewer has doubled, but the sewer has never overflowed.

An ordinance passed in 1898 had required meters on all new water connections, and on all other connections where changes were made (in the number of fixtures?). By 1905, all connections were metered except those made before 1898, and which supplied only one faucet, and that used only for domestic purposes. In 1905 all services except fire lines were ordered metered or the water shut off—which Mr. Houston thinks was going too far, since the order affected poor people, chiefly.

In 1910, it being observed that the pumps would often speed up and run at a 3,000,000-gal. rate from 7 or 8 p. m. until 3 or 4 a. m., "when consumption, through legitimate channels, is at a minimum," it was concluded that this heavy night consumption was due to what water-works men politely call "leaks" in some of the private fire supplies. It was therefore decided to install meters on all fire lines, and on both public and parochial schools. This led to the "most bitter fight" Mr. Houston ever got into in his water-works experience, but meters were placed on all the services in question except two, and those were disconnected by breaking out a section of the service pipes.

These meters disclosed the fact that

in most cases more or less water was being used through the sprinkler lines, and in one particular case, where they claimed that no water was being used, the meter showed a consumption of about 30,000 cu. ft. for the first 24 hrs. after it was installed notwithstanding the fact that, as we have since been advised, they were doing the best they could to shut off the use, as they knew the meter would reveal the fact that they were taking water through the line.

The placing of these meters has resulted in a monthly saving of from 6,000,000 to 8,000,000 gals. of water as compared with the consumption during the same months a year ago, although we have over 500 more connections than we had at that time; and we have been able to maintain pressure at all times throughout the season with

the exception of two or three days, and then the trouble was with the pumps and not from a lack of water.

The remainder of Mr. Houston's paper first gives the results flowing from the use of meters, and then concludes with the interesting remarks on ownership of meters, already mentioned:

During the year ending March 31, 1911, with a population of upwards of 40,000, and with something over 5,300 services, and a revenue from water of over $38,000, we pumped a total of 710,474,683 gals. of water, as against 787,621,902 gals. pumped in 1893 with a population of about 18,000 and with only about 2,500 services and a revenue of only $15,262. This permits of the following deduction:

With a population considerably more than doubled and with more than twice as many services, and with rates lowered more than 10% we increased our revenue over 150% and decreased the amount of water pumped by 77,000,000 gals.

All this was accomplished by the enforced use of meters, and how any municipality that is struggling with the question of an inadequate supply of water will ignore the benefits they might derive from a complete metering of the plant, and continue to pay out the citizens' hard earned money, contributed yearly in the way of taxes, to get an increased supply of water in order that the wasteful may have more to waste, when all they have to do is to properly care for what they have, is too deep a mystery to be fathomed by the writer.

The foregoing relates entirely to the benefits to be obtained from the **use** of meters, and we will now consider briefly another phase of the meter question, namely, **ownership.**

Some contend that it is best for the municipality to retain the ownership of meters for the reason that it gives the city full control in the care and inspection of them, which it could not have were they owned by the consumer.

We do not agree with those who hold this view, as experience has taught us that it makes no difference along this line whether the city or the individual owns the meter, and, as fully 90% of the meters in use in our city are privately owned, we feel as though we were quite well posted on the question.

When we first began the installation of meters we thought best that the city own them, but we soon found that people were very careless about protecting them, particularly against frost, and as we were put to a great deal of trouble as well as expense by reason of such carelessness we set about to find some way out of the difficulty.

We finally hit upon the plan of giving the individual the privilege of either buying a meter outright, or renting it. If he buys it he gets it at cost; and if he rents it, he is charged an annual rental of 25% the cost of the meter and setting same; but is given credit for 40% of all rents paid, which will pay for a meter in full in ten years.

This, as you will probably conclude, is a modest way of forcing people to own the meters, but it has worked out nicely with us.

In handling matters in this way we have never had to make an appropriation for the purchase of meters, except the first one of $4,000, as the moneys received from rentals and the sale of meters has enabled us to keep the wheels revolving, and have a supply on hand at all times, and as we buy them only as we need them, they are generally disposed of before the bill comes due.

We have never had any more trouble exercising full control over privately-owned meters than we have over those owned by the city, and we find that parties who own their meters, as a rule, take more pains in the setting and care of them than do those who rent them.

I presume it might be well to state that we do not rent meters that are above 1½-in. in size, but require them to be paid for when installed, and so do not have any large expensive meters on hand.

In conclusion will say that it is the candid opinion of the writer, that if the suggestions contained in this paper, relative to conserving the supply of water by a complete metering of plants, were to be followed out by many of our cities, where a shortage of water now exists, it would be found, as we found in our case, that they have an abundant supply for all needs and will have for many years to come, and also that if the plan of selling the meters to the consumers were to be followed, there would be no troubble at all in getting a plant completely metered within a short time, with very little expense to the city and with perfect satisfaction to a great majority of the consumers.

Wear of Rails Under Electric Traction.

With the wide introduction of electric traction some special characteristics of rail wear have been developed in many cases, particularly where trains of motor cars are operated on the multiple-unit system. In some cases a special character of wear known as corrugation is caused, in which the head of the rail is given a wavy surface, but excessive wear of the side of the head is more commonly observed. Where unequal action of the brakes, loose couplings, or unequal development of power by the electric motors on a train of cars cause adjacent cars to have independent motion (as in crowding together or lagging behind) the wear is likely to be accentuated. Below are given the results of some inquiries which we have made as to the character of rail wear on lines operated both by motor cars and by electric locomotives.

METROPOLITAN WEST SIDE ELEVATED RY. (CHICAGO).—There is excessive wear on top of the rail, and this wear is peculiar in the fact that it is very uneven and gives the effect of corrugation on top of the rail. Where electric cars are operated in multiple-unit trains, there is a tendency of rear cars to occasionally "crowd" forward upon the preceding cars. With electric cars operated in trains, there seems to be a tendency for the truck to nose against one rail.

SOUTH SIDE ELEVATED RY. (CHICAGO).—There appears to be more rail wear on curves and opposite frogs in special work by trains operated with electricity than by trains operated by steam locomotives. This is probably due to the grinding effect of the wheels connected to the motors, but no comparison has been made as to the relative amount of wear under the two systems. It does not appear that there is any tendency of rear cars to crowd forward upon the preceding cars; nor is there any tendency of the trucks on motor cars to nose against one rail or to swing from rail to rail.

BOSTON ELEVATED RY.—Very excessive rail wear has been noted on the tracks over which the multiple-unit trains are operated. On the tangents, the rails have been in service practically 10 years, but are now beginning to show signs of bad side wear due to the trucks striking first one rail and then the other. On the curves, the rail wear is very great. Curves having radii of 250 ft. or under wear smoothly, while curves of greater radii (up to 3,000 or 4,000 ft.) are badly corrugated. Any small defect in the track, such as an open joint, a weak place in the check rail, etc., will cause a hole to appear in the rail very quickly.

When electric cars are operated in multiple-unit trains, there is sometimes a tendency for the rear cars to crowd forward onto the preceding ones or else a tendency for the forward cars to pull away from the rear ones, due to the power not being applied equally to each car. On this road there has been observed the tendency of the trucks to nose against one rail and to swing from rail to rail on the tangents.

LONG ISLAND R.R.—Where electric motor cars are operated in trains on the multiple-unit system, the wear on the sides of the rail heads on curves is very heavy. There is also a tendency of the rear cars to crowd forward occasionally upon the preceding cars, resulting in the truck of the rear car climbing the lead rails in turnouts. There has not been observed any tendency of the trucks to nose against one rail or to swing from rail to rail.

BALTIMORE & OHIO R. R.—In the Howard St. section of the Belt Line tunnel through the city of Baltimore where electric locomotives are used, there is heavy wear of the rails between Camden and Mt. Royal stations, and also on the curves between Mt. Royal station and Waverly. In the Howard St. section which is practically all on a tangent and with a grade of 0.8% ascending eastward (or opposing the heavy traffic movement), records show that 100-lb. Am. Soc. C. E. Bessemer rail will only last approximately three years. The entire rail is attacked by the gases from the steam locomotives, which gases (in spite of the electric traction) are practically always present to a greater or less degree.* The base of the rail is also subjected to electrolytic action, especially at points in the tunnel where there is more or less water present. At such points the base of the rail is attacked and becomes very thin. The greatest action takes place where the spikes come in contact with the base of the rail, which is eaten in small semi-circular shapes to beyond the spike heads.

The wear on the head of the rail is also very heavy on this section of track. This is specially noticeable on the westbound or downhill track for about the west third of the tunnel's length (the tunnel is 7,200 ft. long), and apparently is due to the use of brakes over this section of the track. The trains are not handled by electric traction on this track, but they, as well as the electric locomotives, drift through the tunnel, and use the brakes quite heavily over this part of the track. This wear amounts to about half of the thickness of the head of the rail over this section of the track, and from one-fourth to one-third of the thickness of the rail head over the remainder of the tunnel. Outside of the tunnel the rail wear is very heavy on the curves. There are several curves of about 10° and the outer rail is cut away rapidly, especially when the flanges of the electric locomotives begin to get sharp. With good flanges the wear is similar to that under steam locomotives, but when the flanges are wearing sharp the rail is cut off in long shavings somewhat similar to the metal shavings from a lathe.

Evidence that the wheels of the electric locomotives nose against the rails has been observed frequently, and the tendency seems to be to swing from side to side. If the flanges are in good condition it is hard to detect evidence of this nosing, but if the flanges are a little sharp marks will be left on the gage side of the rail at regular intervals. The wear, however, from this cause is not serious, and would never be great enough to cause removal of the rail.

NEW YORK, NEW HAVEN & HARTFORD R.R.—Excessive or peculiar rail wear is not noted where electric locomotives are used. Where electric motor cars are operated, a tendency of these cars (at high speed) to swing from one rail to the opposite rail was noticed. The swings usually occur in about 150 ft. intervals. There was similar trouble with the electric locomotives when they had but four driving wheels, without leading wheels. With the present six-wheel trucks this tendency to crowd first one rail and then the opposite rail has been entirely eliminated (on the locomotives). This road, however, has operated multiple-unit service only to a limited extent.

Notes from Engineering Schools.

COLUMBIA UNIVERSITY.—Evening courses of instruction are being offered for day workers who desire to increase their knowledge of such subjects as drafting, designing, drawing, lettering, applied mathematics, applied science, wood and metal working, plant management, merchandising of textiles, business organization, accounting, commercial law, household arts, etc.

BROOKLYN POLYTECHNIC INSTITUTE.—A series of eight lectures on electric-railway engineering and high-tension transmission practice has been announced. This course has been arranged to meet a demand for knowledge of recent developments and present practices. The lecturer is Dr. C. P. Steinmetz, of Schenectady.

An Explosion Wrecked the "Liberte," a large French battleship, Sept. 25, in the harbor at Toulon, France. The accident is ascribed to a fire which got beyond control and reached the powder magazines. It occurred shortly before 6 a. m., the fire having been first discovered at about 4 a. m. The vessel was completely torn to pieces, according to reports, and went down in 40 ft. of water. The first official estimate places the number of men killed at 235, with 160 others injured. The vessel's full complement was 742 men, but about 140 were ashore on leave. Many jumped overboard before the explosion and were picked up

*The electric locomotives haul through the tunnel the entire trains, with steam locomotives attached.

by small boats from other ships, and a few were rescued alive from the wreck. The battleship "Republique," anchored near the "Liberté," was considerably damaged by flying debris from the wrecked vessel.

The "Liberté," with a number of other vessels of the French navy, had been at Toulon since Sept. 4, at which time there was a grand review of the fleet by President Fallieres. The battleship was 439 ft. long with a displacement of 14,900 tons and was regarded as one of the most powerful in the French navy. She was one of the three vessels that represented the French navy at the Hudson-Fulton celebration at New York in 1909. At the time of the explosion, the captain and second officer of the "Liberté," were away on leave and Senior Lieutenant Garnier was in command.

A Grade Crossing Accident at Neenah, Wis., Sept. 24 resulted in the death of 13 persons and the injury of eight others when a Chicago & Northwestern Ry. train struck a hay-ride party. The accident occurred at the Commercial St. crossing, between three and four o'clock in the morning. The hay wagon contained 31 persons who were returning from a social celebration. Reports state that the view of the track was obscured by a large billboard.

A County-Fair Aviator, F. H. Miller, was killed at Troy, Ohio, on Sept. 22. The fuel tank of his machine exploded and the aviator was covered with burning gasoline. His death, however, resulted from the fall of the machine and the impact of the motor which pinned him to the ground.

Anthony Castellane was killed at a county fair in Mansfield, Penn., on Sept. 22. His machine turned over, from some unknown cause, and dropped 500 ft.

C. B. Clarke, an unqualified amateur aviator, was killed at a meet at Nassau Boulevard, Long Island, on Sept. 25. He was making an unauthorized flight and his fall was due to inexperience in handling his machine.

A Molasses Tank, in New Orleans, La., containing 600,000 gals. of molasses, collapsed on Sept. 11 and flooded the surrounding streets and yards with a sticky mass, averaging three feet deep in the immediate vicinity of the tank and spreading out over several city blocks. The tank was an old masonry reservoir built over 60 years ago for the New Orleans Water Works Co., and was used for many years as a surplus supply storage. It was about 400 ft. square and 8 ft. deep, and consisted of two heavy masonry walls filled in between with sand. It was divided by two interior walls into four equal portions, 100 ft. square, and it was in the wall bounding one of these that failure occurred. Some of the molasses ran down the sewers of its own accord, but to remove most of it required the services of the pressure hose of the city fire department. Incidental to the collapse was the plague of flies that came down upon the neighborhood.

A Theater Gallery Collapsed, Sept. 23, at Lisbon, Portugal, causing the death of nine people and the injury of 40 others. Reports state that the gallery was much overcrowded. More than 200 of the 1,000 spectators in the gallery are reported to have fallen into the pit. The theater is an ancient wooden building known as the Ponte Vedra.

Gasoline in the Sewers is assigned as the cause of explosions in New York City, Sept. 25. About 20 manhole covers in the vicinity of 44th St. and Third Ave., were blown into the air. One person was slightly injured. These explosions like those noted in Eng. News, Oct. 14, 1909, p. 419, are ascribed to the presence in the sewers of dirty gasoline from automobile garages.

Seventeen Days from China to New York on a shipment of silk valued at $140,000 has just been recorded. The last stage of the journey was made over the Pennsylvania R. R. The two carloads of valuable goods left Chicago in the morning and arrived in New York on the evening of the next day.

The Gold Output of the Transvaal for the month of July, 1911, according to statistics prepared by the Transvaal Department of Mines, was 711,651.64 fine ounces, valued at about $15,000,000. This is about 24,000 fine ounces more than the production for May, 1911, which was higher than any previous monthly production.

The Mine Rescue Exhibition, noted in Engineering News Aug. 17, has been postponed from Oct. 26-27 to Oct. 30-31.

A Large Ore-Handling Plant will soon be built by the Pennsylvania R. R. at Cleveland, Ohio. The contracts which have been let call for completion of the plant at the opening of navigation in 1912. The installation will be located on the lake front, a short distance from the mouth of the Cuyahoga River, and will have a capacity of some 30,000 tons per day—the load of two large carriers. There will be four unloaders with 17-ton buckets, these being two tons larger than the largest now used. The receiving hopper will have a capacity of 65 tons and the weighing larry 50 tons. An area of 43 acres, at the site, is being reclaimed by filling in between the harbor line and shore. Construction of this unloading plant includes also a 1,000-ft. concrete dock, a 15-ton ore bridge, a haulage system, a railway yard, a crossing under the Lake Shore & Michigan Southern Ry., and a 2,200-KW. power plant.

Joint Sewage-Disposal Works for Dover, Boonton and other municipalities in the drainage area of the Boonton Reservoir of the Jersey City water-supply are under consideration. Before anything can be done, it will be necessary for Jersey City to secure legislative authority to build a trunk sewer and disposal works, and also to maintain the same. It is expected that the various municipalities in the drainage area will vote at the coming November election on the question of building local sewers for connection with the proposed trunk sewer. Conferences have already been had between the authorities of Jersey City and of the other municipalities involved. This project has peculiar interest in view of the fact that in the litigation involving the purchase price to be paid by Jersey City for the storage reservoir and pipe line built some years ago by the Jersey City Water Supply Co., the city maintained that the hypochlorite plant established at the Boonton reservoir of the company did not fulfill the contract requirements as to protecting the Rockaway River from sewage pollution from towns in the drainage area. The court did not allow this claim, but the city seems to be acting in accordance with its contention that sewage-disposal works are necessary for the protection of the water-supply.

Reduced Rates for Stockholders of a public-utility concern have been forbidden by the Wisconsin Railroad Commission. The particular case in hand is that of the Citizens of Platteville against the Platteville, Rewey & Allenboro Telephone Co. The company pled justification on the ground that it was a private enterprise conducted for the mutual benefit of its stockholders. This same company, in a separate case, asked for an increase in rates on account of the necessity of installing a complete metallic return circuit to avoid interference by power circuits. The Commission authorized the company to install a graduated schedule of rates somewhat as desired on the presentation of evidence that the metallic circuit had been installed. It was held in the opinion that the company must keep its accounts in the manner prescribed by law before the Commission could deal with the case intelligently.

The Electrification of the Swiss National Railways will be by the use of the single-phase, overhead-conductor, 15,000-volt system, according to a report in the U. S. Daily Consular and Trade Reports of Aug. 28, 1911. The construction will be patterned after that on the London, Brighton & South Coast Ry., described in Eng. News, June 8, 1911. The first work will be on the St. Gothard line, gradually extending to the whole Federal system of 1,830 miles. The cost is reported to be estimated at $13,140,000, and the running expenses are estimated at 10% less than the present cost of steam operation.

Collapse of a Large Gasholder occurred in Vienna, Austria, on Aug. 5, according to the "Schweizerische Bauzeitung" of Aug. 26, 1911. The structure had just been completed, and apparently was still in the hands of the contractor. The holder was being tested by pumping in air. During this operation the top of the bell suddenly separated from the shell and rolled into the tank below. Twelve men at work on the roof were able to reach safety in the guide frame. The manager of the municipal gas department, Mr. Menzel, stated:

> In a test of the holder, which had already been twice performed successfully, a deformation of the upper ring of the bell took place. Its effect was a buckling of the roof and escape of the enclosed air. The bell sank rapidy into the tank, further distortions occurring during this process. Tank as well as guide-frame remained intact. The damage, about $20,000, falls on the contractor, the Maschinenfabrik Augsburg-Nurnberg. The holder is the largest of its kind on the continent. It had a capacity of 8,800,000 cu. ft., its diameter being 280 ft. and its height 256 ft.

Accidents of this kind are very rare, but still cannot be wholly avoided. However precise the statical calculations, slight errors may occur in the fabrication, or the use of unsuitable material may produce an accident.

An Electromagnetic Tensile-Test Apparatus has been devised by Prof. G. Kapp, Birmingham, England. As described in "Zeitschrift des Vereines deutscher Ingenieure" of Aug. 26, 1911, its special purpose is repetitive or endurance testing. The machine consists of a frame comprising four fixed parallel side bars, a fixed top head in which one end of the test-piece is fastened, a fixed bottom head carrying two pole-pieces projecting up which are surrounded by two exciting coils, and a movable head adapted to slide between the side bars. The movable head in normal position is close to the end faces of the pole-pieces, and serves as armature to the magnet; the lower end of the test-piece is gripped in this head. By sending an alternating current through the magnet windings the armature and test-piece are subjected to a rapid succession of pulls. The pulling force is known when the supply voltage and the air-gap between pole-pieces and armature are known. Apparently no means are provided for adjusting the position of the parts when the test-piece stretches. When a current of 50 cycles is used, giving 100 pulls per second, the number of load applications in 24 hrs. is 8,640,000, so that a very great number of repetitions of load may be secured in a relatively short period.

The apparatus actually built gives 220 lbs. pull with 110-volt current. A piece of steel subjected in this machine to 3,000,000 repetitions of a load of 11,400 lbs. per sq. in. and then tested by ordinary tensile test to rupture showed increased hardness and decreased ductility over its original state.

The Eighth International Congress of Applied Chemistry (through Mr. B. C. Hesse, Secretary, 25 Broad St., New York City), has issued letters to all educational institutions, chambers of commerce, manufacturers, etc., outlining the present organization and asking for cooperation in securing information on subjects of importance. Sectional committees have been organized to build up the program of the congress (to be held in Washington, D. C., and New York City, Sept. 4 to 13, 1912). The fields of these sectional committees are as follows: Analytical chemistry; inorganic chemistry; metallurgy and mining; explosives; silicate industries; organic chemistry; coal-tar colors and dyestuffs; sugar; india rubber and other plastics; fuels and asphalts; fats, oils and soaps; paints, oils and varnishes; starch, cellulose and paper; fermentation; agricultural chemistry; hygiene; pharmaceutical chemistry; bromatology; physiological chemistry and pharmacology; photochemistry; electrochemistry; physical chemistry; law and legislation; political economy and conservation of resources.

A Municipal Sewage Farm is proposed by the city authorities of Deming, N. M., who have bought 40 acres of land, according to reports, on which there will be spread the effluent from a septic tank.

An Interesting Trade-Secret Decision was handed down some time ago by the highest German court. Its effect seems to be quite opposite to what is supposed to be established judicial practice in the matter of trade secrets in the United States. In the German case (reported in "Technik und Wirtschaft" supplement to the "Zeitschrift des Vereines deutscher Ingenieure" of Sept., 1911) several men who had been employed in one works started a competing works and, it is claimed, utilized in the new undertaking their knowledge of various decorative designs of the former employer. The latter sued on the basis of the German law against unfair trade methods, and the lower court decided in his favor. The appeal court reversed this decision, and stated that the members of the new company acted within their lawful rights. Trade secrets which are confided to an employee or which become known to him in legitimate manner may not be disclosed by him to outside parties while he remains in that employ; but the prohibition ends with the period of employ, and thereafter the acquired knowledge may be used in any way, whether or not it involves trade secrets.

Personals.

Mr. Ralph Dare Brown has been made an instructor in civil engineering in the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo.

Mr. A. B. Gidley has resigned his position as City Engineer of Lead, S. Dak., to become City Engineer of Marshfield, Ore. Mr. L. D. Lea has been appointed City Engineer of Lead to succeed Mr. Gidley.

Mr. O. P. Hood, formerly Professor of mechanical and electrical engineering at the Michigan College of Mines, has been made Chief Mechanical Engineer of the U. S. Bureau of Mines, with office at Pittsburg, Pa.

Mr. Charles Russ Richards, M. Am. Soc. C. E., Dean of the College of Engineering of the University of Nebraska, has been made Professor of Mechanical Engineering in charge of the department at the University of Illinois, Urbana, Ill.

Mr. R. G. Carden, formerly a trainmaster of the Missouri Pacific Ry. at Jefferson City, Mo., has been appointed Superintendent of the Northern Kansas division with headquarters at Atchison, Kan., succeeding Mr. J. F. Russ, who has been promoted to the superintendency of the Omaha division.

Mr. John C. Stubbs, Vice-President and Director of Traffic of the Oregon-Washington R. R. & Navigation Co., the Oregon Short Line R. R., the Southern Pacific Ry., and the Union Pacific R. R., has announced, according to press reports, that he will retire on Jan. 1.

Mr. George H. Garrey has opened an office at San Francisco, Cal., for practice as a consulting specialist in mining geology, and will undertake the appraisal of possibilities of mining property and the outlining of development work for mines. He was formerly economic geologist with the U. S. Geological Survey, mining geologist with the American Smelters Securities Co., and manager of the southern division of Spurr & Cox.

Obituary.

Charles Arthur Matcham, M. Am. Soc. C. E., died Sept. 22 at his home in Allentown, Pa., aged 49 years. Mr. Matcham was General Manager of the Allentown Portland Cement Co. and is credited with inventions in cement-making machinery. He is survived by his wife and three children.

Thomas M. King, formerly General Superintendent and Vice-President of the Baltimore & Ohio R. R., died Sept. 13 at his home in Irvington-on-the-Hudson, N. Y. Mr. King was born at Freeport, Armstrong Co., Pa., in 1843, and entered the service of the Allegheny Valley R. R. in 1858 as a platform clerk. During the Civil War he served for a time as Assistant Superintendent, U. S. Military Ry. Service, in charge of the line between Harper's Ferry and Winchester, Va. In 1868 he returned to the Allegheny Valley R. R. as Superintendent of the Pittsburgh division and remained in this position until 1881, when he was made General Superintendent of the Baltimore & Ohio R. R. He was promoted to be Second Vice-President of the same road in 1884 and held this position until November, 1899.

He was also President of the Pittsburgh Southern and Pittsburgh Junction R. Rys. from 1882 to 1899, was Vice-President and General Manager of the Pittsburgh & Western R. R. in 1884 and was President of the last-named road from 1893 to 1900.

John Souther, one of the oldest iron manufacturers in the country, died at his home in Newton, Mass., Sept. 12, after a two days' illness. Mr. Souther was born in 1817 at South Boston and was educated at the old Hawes school in that place. He served an apprenticeship in a foundry and at the age of 17 years made patterns for the fence around Boston Common, part of which is still in use. Later he founded the Globe Locomotive Works and continued in active business until 1881 when he retired. His works at Boston are still operated, making excavating machinery under the name of John Souther & Co. Mr. Souther is credited with being the builder of the first steam shovel and steam dredging machinery and was the builder of the first locomotive to take a train across the continent upon the completion of the Union Pacific and Central Pacific Rys. Excavating machinery, built by him, was used on the Suez Canal and by the French in their work on the Panama Canal. During the Civil War his plant was used by the U. S. Government for constructing the machinery of 16 war vessels.

Mr. Souther was married in 1842 to Olive R. Ware. Two of their children survive, Mr. John F. Souther, of Arlington, and Miss Ella J. Souther, of Newton, Mass.

Engineering Societies.

COMING MEETINGS.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10-17. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at St. Louis, Mo. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Oct. 24-28. Annual session at Chicago, Ill. Secy., J. F. Calbreath, Denver, Colo.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 2-4. Annual meeting at Cincinnati, Ohio. Secy., Edward H. Reisner, 20 West 44th St., New York City.

NATIONAL MUNICIPAL LEAGUE.
Nov. 13-16. Annual meeting at Richmond, Va. Secy., Clinton R. Woodruff, 705 North American Bldg., Philadelphia, Pa.

AMERICAN ROADBUILDERS' ASSOCIATION.
Nov. 14-17. Annual convention at Rochester, N. Y. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN RAILWAY ASSOCIATION.
Nov. 15. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York City.

NATIONAL FOUNDERS' ASSOCIATION.
Nov. 15-16. Annual convention at New York City. Secy., F. W. Hutchings, 915 Hammond Bldg., Detroit, Mich.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting at New York City. Acting Secy., D. H. Cox, 29 West 39th St., New York City.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 17-18. Annual meeting at Canton, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

Municipal Engineers of the City of New York.

At the regular meeting of Sept. 27, Mr. Nelson P. Lewis, Chief Engineer of the New York City Board of Estimate and Apportionment, presented a paper entitled "The City Plan and What It Is."

American Institute of Mining Engineers.

Regulations for the establishment of local sections are published in the September "Bulletin." Among the 18 articles of the regulations are the following:

1. A local section of the Institute may be authorized by the Council at the written request of ten members residing within an appropriate distance of a central point.
2. Only one section shall be authorized in one locality or district.
3. The Council shall define the territory of a section.
4. A section must consist of 25 or more members; when its membership falls below 25 in number the Council may annul the section.
5. Only members of the Institute shall be members of its local sections.
6. All members of the Institute, of all grades, residing within the territory of a section shall ipso facto constitute the membership of such section.
9. Whenever the Institute is financially able to do so, it shall be the policy of its Board of Directors to contribute from its funds for the legitimate running expenses of each local section an amount not exceeding, in each year, 25% of the dues received from the members of said section in said year. Requests for such appropriations shall be signed by the chairman, secretary and treasurer of the section.
11. The Institute reserves the right to cancel a section, or re-adjust its territory.
17. The by-laws and regulations of local sections shall be subject to the approval of the Council.

South Dakota Engineering Society.

The following report of the first annual meeting of this society at Deadwood, S. Dak., Aug. 23-25, has been received from Mr. Samuel H. Lea, M. Am. Soc. C. E.

The sessions were held at the Business Club rooms and the headquarters were at the Franklin Hotel. There were many papers listed on the program, but, owing to the absence of several of the expected speakers, all these were not presented. The society has been organized only about six months and since its membership is at present small, a large attendance was not looked for. The interest manifested in the meeting was gratifying, giving promise of permanency and growth. The reports of officials showed a prosperous condition of the society, both financially and in membership. The social features of the meeting included a reception and ball given by the local committee at the Franklin Hotel in Deadwood, and a luncheon at the Smead Hotel in Lead City.

At the opening session, Mayor W. E. Adams welcomed the engineers to Deadwood and spoke of the great vaue of their work to society in general. The annual address of the president, Samuel H. Lea, referred to the appropriateness of the engineers meeting in the Black Hills, where are so many industrial enterprises and great engineering projects under way. Special reference was made to the mining industries at Deadwood and Lead, the large water-power developments now going on in the Black Hills, and to the great reclamation project at Belle Fourche.

A paper on "The Valuation of Public Utilities," by C. C. Witt, late engineer for the State Board of Railroad Commissioners, in the absence of Mr. Witt, was read by Secretary R. G. Culbertson. This paper gave a historical sketch of the work of valuing railway property in some of the western states, with reference to similar work now going on in other states. Especial reference was made to Mr. Witt's work in making an appraisal of all the railway property in South Dakota.

A paper on "The Design of a 50-ft. Reinforced-Concrete Bridge" was read by C. G. McHugh, of Mitchell. The value of proper design for safety and permanence was emphasized, and the folly of the acceptance of a cheaply designed structure by boards or commissions was pointed out. The result of a recent competition between contractors for a bridge of this description was given and a conclusion drawn therefrom.

W. R. Putnam, General Manager of the Dakota Power Co., read a paper on "The Value of Hydro-Electric Power as Compared with Steam and Gas Power." This paper discussed the situation in South Dakota where fuel is high and the distances great between manufacturing centers. The conclusion is reached that in general a gas-engine plant will cost from 18 to 33⅓% more than a steam plant; and a hydro-electric plant from 33 to 66⅔% more than a gas-engine plant. A chart was exhibited to show graphically the variation in annual cost of production of the three different kinds of power.

A paper on "The Improvement of Public Institution Grounds," was presented by Samuel H. Lea, State Engineer. The improvement of grounds surrounding public institutions was discussed and some general suggestions offered concerning plans and methods of work. Special reference was made to the improvement of the State Capitol grounds at Pierre, which is now being done under Mr. Lea's supervision.

C. W. Hough, of Deadwood, General Manager of the Consolidated Power & Light Co., spoke on the treatment of persons who have been rendered unconscious by an electric shock. R. G. Culbertson spoke on the commercial side of engineering, giving an explanation of methods employed by a large engineering company in keeping track of field and office expenses. An interesting historic paper was presented by B. C. Yates, Assistant Chief Engineer for the Homestake Mining Co. This paper described some of the notable features of the Homestake mine at Lead City, and also outlined the development of the mine from the beginning to its present status as the largest gold mine in the world.

On Thursday, Aug. 24, the members visited Lead City and were lowered at the Ellison hoist to the 1,100-ft. level of the Homestake mine. After an inspection of the underground workings, a privilege rarely accorded to visitors, they were taken to the surface through the Star shaft, and shown the surface plant of the mine. On Friday morning a visit was made to the Pluma plants of the Consolidated Power & Light Co. and the Mogul Mining Co. In the afternoon the members were taken to the diversion dam of the Homestake Hydro-Electric plant in Spearfish Canyon. From here they went through the tunnel constructed for a conduit between the dam and forebay of power plant. This conduit is in reality a series of tunnels, aggregating nearly five miles in length through solid rock. The trip was made in cars pushed ahead of a small locomotive on a track extending the entire length of the tunnel. This trip terminated the meeting.

The present officers of the society were continued for another year. The location for the next meeting was not determined upon, but will be decided later by letter ballot.

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